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SPORT FISHERY ABSTRACTS

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DEPARTMENT OF THE INTERIOR
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SPORT FISHERY ABSTRACTS

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Sport Fishery Abstracts is intended to furnish fishery biologists with abstracts of current literature in sport fishery research and management.

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SPORT FISHERY ABSTRACTS

An abstracting service for fishery research and management

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AQUATIC PLANTS AND THEIR CONTROL

76-000001 Edwards, D. J.; Moore, E. (N.Z. Minist. Agric. Fish., P. O. Ngapuna, Rotorua, New Zealand) CONTROL OF WATER WEEDS BY GRASS CARP IN A DRAINAGE DITCH IN NEW ZEALAND. N. Z. J. Mar. Freshwater Res. 9 (3): 283-292. Sept. 1975. SFA 21(1).

Two-year-old grass carp *Ctenopharyngodon idella* Val. were stocked at a rate of 350-650 kg/ha in a farm drainage ditch in the Bay of Plenty, New Zealand. During the months December to April the fish greatly reduced the standing crop and percentage cover of the weeds *Callitriche stagnalis* Sccp. and *Nasturtium officinale* R.Br., but had no effect on *Polygonum decipiens* R.Br.

GENERAL FISH CULTURE

76-000002 Adams, J. C.; Kilambi, R. V.; Wickizer, W. A.; Brown, A. V. (Dep. Zool., Univ. Ark., Fayetteville 72701) CHANGES IN MACROBENTHOS POPULATIONS IN AN ARKANSAS RESERVOIR SUBSEQUENT TO CAGE CULTURE OF FISH. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

A three year investigation was conducted to determine possible effects of cage culture of fish on the biotic and abiotic environment of Crystal Lake, Arkansas. The study was divided into three periods: Pre- (November 1971-October 1972), during- (November 1972-October 1973), and post- (November 1973-October 1974) cage culture of rainbow trout and channel catfish. Of thirteen physicochemical parameters monitored, ortho- and metaphosphate, nitrite and nitrate nitrogen and turbidity showed significant increases during the study. Total annual standing crops of phytoplankton, zooplankton, benthos, and natural fish populations were higher during and after fish culture.

The most abundant taxa (greater than 97 percent) of benthic macroinvertebrates during the study were *Chaborus* sp., Chironomidae, and Oligochaeta. *Chaoborus* was the dominant benthic organism before culture (greater than 62 percent), however, a shift to an oligochaete-dominated (greater than 58 percent) benthos structure occurred after fish culture. Large deposits of fish feces accumulated as sediments at the cage site and probably contributed to the changes in macrobenthos.

76-000003 Collins, M. T.; Gratzek, J. B.; Dawe, D. L.; Nemetz, T. G. (Dep. Med. Microbiol., Coll. Vet. Med., Univ. Ga., Athens 30602) EFFECTS OF ANTIBACTERIAL AGENTS ON NITRIFICATION IN AN AQUATIC RECIRCULATING SYSTEM. J. Fish. Res. Board Can. 33 (2): 215-218. Feb. 1976. In English with French summ. SFA 21(1).

Treatment of recirculating systems with a single dose of erythromycin (50 mg/liter) resulted in nitrate reduction and stopped nitrification for 14 days as evidenced by changes in pH and ammonia, nitrite and nitrate concentrations. Treatment of systems with 2-chloro-6-(trichloromethyl) pyridine, a known nitrification inhibitor,

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76-000003 CONTINUED

inhibited nitrification similarly. Treatment with chlcrampenicol (50 mg/liter), oxytertracycline (50 mg/liter), sulfamerazine (50 mg/liter), or nifurpirinol (1 mg/liter) had no effect on nitrification.

76-000004 Ihssen, P. (Fish. Wildl. Res. Branch, Ontario Minist. Nat. Resour., Maple, ON L0J 1E0, Canada) SELECTIVE BREEDING AND HYBRIDIZATION IN FISHERIES MANAGEMENT. J. Fish. Res. Board Can. 33 (2): 316-321. Feb. 1976. In English with French summ. SFA 21(1).

Selective breeding of fish using quantitative genetic techniques is discussed. Fish offer advantages over other livestock for selective breeding procedures because of their relatively high reproductive potential and low reproductive barriers.

Maintaining fish stocks in artificial environments can cause undesirable genetic changes such as loss in heterozygosity due to inbreeding and loss in fitness. Methods to minimize inbreeding are given. The study of cross breeds on inbred lines, and hybrids among strains or even species, to produce high levels of heterozygosity and heterosis or hybrid vigor is suggested.

76-000005 U.S. Fish and Wildlife Service (Washington, DC 20240) PROPAGATION AND DISTRIBUTION OF FISHES FROM NATIONAL FISH HATCHERIES FOR THE FISCAL YEAR 1974. U.S. Fish Wildl. Serv. Fish. Dist. Rep. 9. 62p. 1975. SFA 21(1).

76-000006 Zeitoun, I. H.; Ullrey, D. E.; Magee, W. T.; Gill, J. L.; Bergen, W. G. (Dep. Anim. Husb., Mich. State Univ., East Lansing 48824) QUANTIFYING NUTRIENT REQUIREMENTS OF FISH. J. Fish. Res. Board Can. 33 (1): 167-172. Jan. 1976. In English with French summ. SFA 21(1).

Four replicates of 50 rainbow trout (*Salmo gairdneri*) fingerlings each were assigned to each of seven dietary protein levels from 30 to 60 percent in 5 percent increments. Percentage weight gains for 10 wk were related to dietary protein levels using an analysis of variance and multiple comparisons of the means, a "broken line" analysis, and a polynomial regression analysis. When correctly used, one of these techniques should lead to a reasonable conclusion concerning dietary protein requirements. However, the polynomial regression analysis has the advantage of being continuous, like the relation of growth to dose, and should be more accurate than the other methods when the intervals between experimental dietary nutrient concentrations are made. The polynomial regression analysis also provides the basis for making economic decisions relative to protein requirements for maximum economic returns.

TROUT AND SALMON CULTURE

76-000007 Hahn, D. R. THE BIOLOGICAL AND ECONOMIC ASPECTS OF CAGE REARING RAINBOW TROUT, *SALMO GAIRDNERI*/ RICHARDSON, IN NORTH DAKOTA. Ph.D. dissertation, Univ. N. Dak. 192p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(10), 1975. SFA 21(1).

This investigation was designed to determine the biological and economic feasibility of rearing rainbow trout, *Salmo gairdneri*/ Richardson, in cages in North Dakota. Varying densities of fish were reared and fed in floating cages. An incomplete block design was used to evaluate the growth, mortality, and food conversion by test fish. Environmental parameters such as water and air temperature, dissolved oxygen, and turbidity were measured daily and their effects evaluated.

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Natural foods potentially available to caged fish were determined. Flesh analyses and palatability tests of caged trout were compared with similar data from wild rainbow trout from the same lake. In general, caged trout grew and converted food better than most reported in the literature. However, high ambient water temperatures reduced survival and growth below that of the native trout. The caged trout were superior to the local wild trout in flavor and had a good shelf life. Contribution of natural food organisms to the caged trout diet was negligible. High production costs make cage rearing of rainbow trout economically infeasible at this time.

76-000008 Kincaid, H. L.; Bridges, W. R.; Thomas, A. E.; Donahoo, M. J. (U.S. FWS, Fish Genet. Lab., Beulah, WY 82712) REARING CAPACITY OF CIRCULAR CONTAINERS OF DIFFERENT SIZES FOR FRY AND FINGERLING RAINBOW TROUT. Prog. Fish-Cult. 38 (1): 11-17. Jan. 1976. SFA 21(1).

Tests of three circular containers of different sizes for rearing small rainbow trout (*Salmo gairdneri*) were made to determine optimum fish-loading density. The optimum density ranged from 0.04 to 0.08 kg of fish per liter of container volume in tanks with a volume of 8.5 to 50.0 liters and inflow rates of 1.5 to 2.3 l/min. For fish ranging from swim-up fry to 10-g fingerlings, tank volume was the factor which most rapidly limited growth rate; thereafter fish size became the limiting factor. Later tests in circular tanks 122 cm (48 in.) in diameter demonstrated that mild growth inhibition during initial periods in smaller rearing units was overcome within 6 weeks after the fish were transferred to larger tanks.

76-000009 Ott, A. G. CRYOPRESERVATION OF PACIFIC SALMON AND STEELHEAD TROUT SPERM. Ph.D. dissertation, Oreg. State Univ. 160p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(5), 1975. SFA 21(1).

Successful fertilization of fresh steelhead trout, pink salmon, kokanee, chum salmon, fall chinook salmon, and coho salmon eggs with cryopreserved sperm is reported in this thesis. A mean percent fertilization greater than 50 percent was achieved for all species tested except chum salmon.

In the cryopreservation of salmonid sperm, dilution ratios of 1:4 and 1:9 were acceptable; and when dimethyl sulfoxide was utilized as the solute moderator, equilibration was unnecessary. Extenders were developed for each species with the most significant advance being development of a simplified diluent containing only NaCl, NaHCO₃, and lecithin. The preferred life protector was dimethyl sulfoxide, and protection was accomplished at levels between 7.5 and 12.0 percent (v/v) depending on the species tested.

The preferred freezing procedure consisted of placing an ampoule (unsealed) of diluted semen in the vapor of liquid nitrogen (LN(2)) for at least 1 min prior to immersion in LN(2) for storage. Storage times approaching one month did not affect sperm viability as determined by mean percent fertilization of fresh ova; longer holding times appear practicable.

The thawing procedure was determined to be critical in terms of sperm survival after freezing. The optimal technique consisted of filling the neck of an unsealed ampoule of frozen sperm with 4-10 C water, and then swirling the ampoule in a 50-60C bath for 8 sec. When water was added to the ampoule of frozen sperm during thawing, cells equilibrated, thaw rate increased, agglutination decreased, and mean percent fertilization increased. (From Auth. Abstr.)

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WARMWATER CULTURE

76-000010 Colt, J.; Tchobanoglous, G.; Wong, B. (Dep. Civ. Eng., Univ. Calif., Davis 95616) THE REQUIREMENTS AND MAINTENANCE OF ENVIRONMENTAL QUALITY IN THE INTENSIVE CULTURE OF CHANNEL CATFISH. AN ANNOTATED BIBLIOGRAPHY. Dep. Civ. Eng., Univ. Calif., Davis viii + 126p. June 1975. SFA 21(1).

76-000011 Janisch, J. L. (Ind. Dep. Nat. Resour., Div. Fish Wildl., Indianapolis 46204) LARGEMOUTH BASS GROWTH RATES IN REARING PONDS STOCKED WITH ADULT FORAGE FISH. Prog. Fish-Cult. 38 (1): 42-43. Jan. 1976. SFA 21(1).

Raising largemouth bass, *Micropterus salmoides*, to a length greater than 4 in. requires large amounts of forage and is generally not considered feasible; adding forage minnows or providing an artificial diet are the two recommended methods of raising large fingerling bass. As an alternative, adult forage fish (bluegills, *Lepomis macrochirus*; gizzard shad, *Dorosoma cepedianum*; and goldfish, *Carassius auratus*) were stocked at a rate of 15 lb/acre with about 2,000 3-in. largemouth bass fingerlings per acre in April 1973; largemouth bass fingerlings with an average length of 6.6 in. were harvested in February 1974.

76-000012 Newton, S. H. EVALUATION OF RACEWAY SYSTEMS FOR THE PRODUCTION OF CHANNEL CATFISH (*ICTALURUS PUNCTATUS*) FINGERLINGS. Ph.D. dissertation, South. Ill. Univ. 89p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

Three different systems were designed, constructed, and evaluated during four consecutive growing seasons (1969-1972). Channel catfish fingerlings (10-14 days old) were stocked in each system. A gravity flow, low-pressure, high-volume water supply system was the most satisfactory of the three systems evaluated. A fresh-water exchange rate of 3-4 times per hour maintained adequate water quality in this system during 1971 and 1972. Generally, fingerling survival was low in all raceway systems. The first month following hatching appears to be the most critical period for catfish fry. Highest survival (greater than 90 percent) was achieved in 1971 when fry were stocked in a pond 5-8 weeks prior to placing them in raceways. Increase in survival obtained with this procedure suggests that fingerlings can be successfully reared in raceways. External protozoan parasites were successfully controlled with formalin; however, bacterial infections were not controlled with the antibiotic treatments used. Predaceous insects were avoided in the raceways by use of screen covers. It appears that production of catfish fingerlings in raceways may be feasible only by using the pond to raceway transfer method. Any further advancement toward rearing catfish fingerlings in raceways without first transferring them to ponds will be dependent upon understanding the cause of mortality during their first 5-6 weeks of life. (From Auth. Abstr.)

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76-000013 University of Wisconsin Sea Grant College Program (Sea Grant Communications Office, 1800 University Avenue, Madison, WI 53706) AQUACULTURE: RAISING PERCH FOR THE MIDWEST MARKET. Univ. Wis. Sea Grant Coll. Prog. Advis. Rep. No. 13. viii + 87p. June 1975. SFA 21(1).

Proceedings of a conference sponsored by the University of Wisconsin Sea Grant College Program, the Department of Food Science and the University of Wisconsin--Extension on April 16, 1975. Contains nine technical papers on production and marketing of yellow perch (*Perca flavescens*). (RS)

MARICULTURE

76-000014 Hunter, J. R. (NMFS, La Jolla Lab., La Jolla, CA 92038) CULTURE AND GROWTH OF NORTHERN ANCHOVY, *ENGRAULIS MORDAX*, LARVAE. NOAA Fish. Bull. 74 (1): 81-88. Jan. 1976. SFA 21(1).

Culture techniques used to rear larval anchovy through metamorphosis using laboratory cultured foods are described. Anchovy larvae fed dinoflagellates *Gymnodinium splendens*, rotifers *Brachionus plicatilis*, harpacticoid copepods *Tisbe furcata*, and brine shrimp nauplii *Artemia salina*, completed metamorphosis (35 mm) in 74 days at 1 C with a minimum survival of 12.5 percent. Growth in length and weight were recorded over this interval and an excellent fit to the Laird-Gompertz growth equation was obtained. Growth was comparable to that on a wild plankton diet. In a starvation experiment, most of the fish that completed metamorphosis withstood a starvation period of 12-15 days, whereas those that had not completed metamorphosis did not.

76-000015 Powell, M. R. (Ala. Dep. Conserv. Nat. Resour., Claude Petiet Mariculture Cent., Gulf Shores 36542) RESISTANCE OF COPPER-NICKEL EXPANDED METAL TO FOULING AND CORROSION IN MARICULTURE OPERATIONS. Prog. Fish-Cult. 38 (1): 58-59. Jan. 1976. SFA 21(1).

The resistance of a 90 percent copper, 10 percent nickel expanded metal to fouling and corrosion was tested at the Dauphin Island Laboratory Division of the Alabama Marine Resources during studies of cage culture of fish in 1973-74. The alloy was superior to the commonly used vinyl-coated steel hardware cloth in anti-fouling qualities, durability, resistance to corrosion, and longevity. Despite its high cost, 90-10 copper-nickel expanded metal could find many uses in mariculture, especially for rearing fish with high market values.

76-000016 Williams, S. F. REARING CONDITIONS AND THEIR EFFECTS ON GROWTH, FOOD CONVERSION, AND SURVIVAL OF ENGLISH SOLE (*PAROPHRYS VETULUS*/GIRARD). Ph.D. dissertation, Oreg. State Univ. 102p. 1975. From Diss. Abstr. Int. E Sci. Eng. 35(12), 1975. SFA 21(1).

Rearing of the larvae to the juvenile stage was attempted unsuccessfully; techniques used and problems encountered during culture are discussed. Growth of juveniles was studied at combinations of temperatures and daily rations of the diet Oregon Moist Pellet ranging from 9.5 to 21 C and from zero to 16 percent of dry body weight. The effects of diet (artificial versus natural), population density, and dominance behavior on growth were also studied. Acutely tested tolerance (96 hour bioassay) to salinities in the range of 0 to 34‰ was determined.

In the temperature-ration experiment, fastest growth of the juveniles (0.95 percent/day) occurred at the lowest temperature and highest ration. Growth declined with decreasing ration and increasing temperature. For fish fed Oregon Moist Pellet the maintenance ration

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was determined to be 3.1 percent at 9.5 C, increasing to 4.7 percent at 18. Highest food conversion occurred at the lowest temperature and the 8 percent ration. Food conversion declined with increasing temperature and at rations greater than 8 percent.

At the same restricted ration (8 percent), juveniles grow much faster on a clam-shrimp diet (1.16 percent/day), which was thought to be a more natural diet, than the Oregon Moist Pellet diet (0.42 percent/day). Despite the faster growth on the natural diet, mortality during the experiment was higher in groups fed the clam-shrimp diet (32 percent) than in groups fed the Oregon Moist Pellet diet (3 percent).

Over the range of initial population densities of 0.5 to 5.3 kg/m³ no differences in growth rate were observed. In later experiments juveniles were reared at densities up to 15.1 kg/m³ without mortalities nor slowing of growth.

Salinities down to 3.30‰ were tolerated by laboratory adapted juveniles for 96 hours without dying. At 1.30‰ salinity the time to 50 percent mortality at 9.5 C (46 hours) was twice that at 16.5 C (23 hours) for 0-group sole. At 1.60‰ salinity and 16.5 C, the time to 50 percent mortality was 1.5 times greater than with 0-group fish (24 hours) compared with I-group fish (16 hours).

Diseases encountered during the experiments included gyrodactyliasis, caused by the monogenetic trematode *Gyrodactylus*., and three presumed bacterial infections: a fin rot, a coldwater lesion-producing disease, and a systematic bacterial infection, probably vibriosis. (From Auth. Abstr.)

FEEDS, FEEDING AND NUTRITION

76-000017 Choubert, G., Jr.; Luquet, P. (Lab. Nutr. Poissons, Cent. Natl. Rech. Zootech., I.N.R.A., 78350 Jouy en Josas, France) NATURE DES CAROTENOIDES FIXES AU NIVEAU DE LA PEAU ET DU MUSCLE DE LA TRUITE ARE-EN-CIEL AYANT INGERE DE L'HUILE ROUGE DE CAPELAN. [FEEDING TEST OF CAPELIN OIL (*MALLOTUS VILLOSUS* M.) ON RAINBOW TROUT: AMOUNT AND QUALITIES OF CAROTENOID CONTENTS IN THE MUSCLE AND SKIN.] Ann. Hydrobiol. 6 (2): 123-130. 1975. In French with English summ. SFA 21(1).

Diets containing 4 p. 100 (group 1) and 17.8 p. 100 (group 2) Capelin oil (carotenoid content 50 p.p.m.) were fed to rainbow trout (*Salmo gairdneri* RICH.) for a period of 9 weeks.

The following carotenoids were isolated and identified from Capelin oil: beta-carotene (5 p. 100) astaxanthin diester (50 p. 100) astaxanthin monoester (28 p. 100) astaxanthin in the free form (16 p. 100).

While the muscle of rainbow trout was found to contain only astaxanthin in the free form; beta-carotene, echinenin, astaxanthin monoester were found in the skin. Some discussion was made on the formation of echinenin.

The carotenoid contents of skin were higher than muscle (X 10). Both were highest in group 2.

No increase in carotenoid level was noted in juvenile rainbow trout. (Auth. Summ.)

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76-000018 Davis, E. M.; Rumsey, G. L.; Nickum, J. G. (Dep. Nat. Resour., Cornell Univ., Ithaca, NY 14853) EGG-PROCESSING WASTES AS A REPLACEMENT PROTEIN SOURCE IN SALMONID DIETS. Prog. Fish-Cult. 38 (1): 20-22. Jan. 1976. SFA 21(1).

Fingerling lake trout (*Salvelinus namaycush*) fed a diet in which 50 percent of the fish meal protein was replaced by dried egg-processing waste material showed growth rates and feed conversion efficiencies closely similar to those of fish fed a diet in which no fish meal was replaced. The feasibility of using a waste product as a protein replacement was demonstrated and the value of using chicken egg protein in fish diets was established.

76-000019 Sarokon, J. A. FEEDING FREQUENCY, EVACUATION, ABSORPTION, GROWTH AND ENERGY BALANCE IN RAINBOW TROUT, *SALMO GAIARDNERI*. Ph. D. dissertation, Univ. Colo. 71p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(5), 1975. SFA 21(1).

This study was designed to investigate the effect of feeding frequency on evacuation, absorption, growth and energy balance of young-of-the-year rainbow trout, *Salmo gairdneri*, fed a pelleted diet or caddis fly larvae, *Limnephilus* sp.

At a water temperature of 15 C, percent evacuation at 24 hours for fish consuming one, two or three meals of pellets averaged 74.1 percent with no significant difference between groups. Fish consuming two, four, six or eight meals of pellets at a water temperature of 11 C, evacuated an average of 67.1 percent in 24 hours and showed no difference between groups. Fish consuming double rations of pellets on alternate days had evacuation rates about 70 percent faster than fish consuming single rations daily. Fish consuming caddis larvae at frequencies of two meals/day, eight meals/day and two meals on alternate days evacuated significantly more when fed on alternate days.

Fasts of three and six days reduced evacuation by 16 and 21 percent, respectively, when compared to fish fed two meals daily. About four days of continuous feeding was required for evacuation to return to the control level following a three-day fast, whereas following a six-day fast the process approached the control level only after six days of resumed feeding.

A six-week study with the pelleted diet and a four-week study with caddis larvae were undertaken to determine the effect of feeding frequencies of two meals/day, eight meals/day and two meals on alternate days on growth, absorption and energy balance. Growth as wet weight gain was similar at all feeding frequencies with each diet. Absorption efficiencies for the pelleted diet, determined by the indirect chromic oxide (Cr_2O_3) method, were not statistically different for fish consuming two or eight meals daily. However, fish consuming double rations on alternate days had significantly lower absorption efficiencies. This reduced efficiency appeared to be the result of incomplete digestion due to increased rate of gastric evacuation. Absorption efficiencies for fish fed caddis larvae were determined by a direct method which indicated no significant difference as a result of feeding frequency.

With both diets fish utilized approximately 25 percent of absorbed energy for growth and 75 percent for specific dynamic action (SDA), standard metabolism and activity. No significant differences were observed as a result of feeding frequency on the caddis larvae diet. SDA was significantly lower for fish fed pellets on alternate days. This appeared to result from lower absorption in this group. SDA required 65 percent of the total energy of respiration for fish fed pellets. Fish fed caddis larvae utilized only 10 percent of the total energy of respiration for SDA. This difference appeared to be the result of low dry-matter intake of caddis larvae. (From Auth. Abstr.)

AQUARIUMS

76-000020 Balderston, W. L. DENITRIFICATION IN CLOSED-SYSTEM AQUACULTURE. Ph.D. dissertation, Univ. R. I. 140p. 1974. From Diss. Abstr. Int B Sci. Eng. 35(12), 1975. SFA 21(1).

In order to avoid the problems of reproducibility and toxicity as well as the collection and storage of natural sea water, an autoclavable, seven salt artificial sea water was formulated for routine biological and microbiological studies. It was found to be equal to natural sea water in supporting the growth of a marine bacterium, a marine yeast and marine phytoplankton. The larvae of rock crab (*Cancer irroratus*) and lobster (*Homarus americanus*) survived well in artificial sea water (compared to natural sea water) if trace metals were removed by autoclave precipitation. The larvae of winter flounder (*Pseudopleuronectes americanus*) and scup (*Stenotomus chrysops*) showed similar survivals while tautog larvae (*Tautoga onitis*) exhibited a need for trace metals. This artificial sea water has been used in other biological and chemical studies in this laboratory with excellent results for four years. These observations appear to confirm our contention that in formulating an artificial sea water for biological purposes, attention should be paid to removing excess trace metals that contaminate the basal salts rather than compounding the problem by the further addition of unnecessary trace metals.

Columnar denitrification as a method of nitrate removal from closed-system salmonid aquaculture water was investigated and found to be feasible. Laboratory columns made from limestones colonized by a nitrifying microbiota were capable of 100 percent nitrate removal after a 20 day development period when methanol was used as the carbon and energy source and the salmonid culture water was used as the inoculum. Scanning electron microscopy showed that the bacterial flora was mainly rod forms with the *Peritricha* dominating as the primary consumers. (From Auth. Abstr.)

76-000021 Garling, D. L., Jr.; Wilson, R. P. (Dep. Biochem., Miss. State Univ., Mississippi State 39762) INEXPENSIVE CONSTANT WATER LEVEL DEVICE FOR FLOW-THROUGH AQUARIUMS. Prog. Fish-Cult. 38 (1): 52-53. Jan. 1976. SFA 21(1).

An inexpensive device was designed and constructed to maintain constant water levels for flow-through aquariums. A U-tube principal was used to maintain equal water levels in two separate containers (the aquarium and the constant-level apparatus). Each device can be constructed from readily available materials for about \$1.56.

76-000022 Penrose, W. R.; Squires, W. R. (Fish. Mar. Serv., Biol. Stn., Water St. East, St. John's, NF A1C 1A1, Canada) TWO DEVICES FOR REMOVING SUPERSATURATING GASES IN AQUARIUM SYSTEMS. Trans. Am. Fish. Soc. 105 (1): 116-118. Jan. 1976. SFA 21(1).

Gas supersaturation in aquaria can be relieved by treatment of inflowing water with suitable apparatus. Two devices have been developed for this purpose. The first uses controlled agitation of falling water to bring about equilibrium and operates at flow rates near 40 liters/min; the second agitates the seawater with compressed air and is useful in the flow rate range 0 to 3 liters/min. These designs are modifiable to other flow rates.

MISCELLANEOUS CULTURE TECHNIQUES AND EQUIPMENT

76-000023 Bahner, L. H.; Nimmo, D. R. (U.S. EPA, Gulf Breeze Environ. Res. Lab., Sabine Island, Gulf Breeze, FL 32561) PRECISION LIVE-FEEDER FOR FLOW-THROUGH LARVAL CULTURE OR FOOD CHAIN BIOASSAYS. Prog. Fish-Cult. 38 (1): 51-52. Jan. 1976. SFA 21(1).

The simple electronic timer-controlled feeder described is suitable for larval culture, nutrition experiments, and food-chain bioassays in flow-through systems. A wide range of precise feeding rates is possible and a variety of foods can be delivered simultaneously. Components for the feeder can be purchased for approximately \$40.00.

76-000024 Kincaid, H. L.; Bridges, W. R.; von Limbach, B. (U.S.FWS, Fish Genet. Lab., Beulah, WY 82712) REARING SYSTEM FOR SMALL GROUPS OF EXPERIMENTAL FISH. Prog. Fish-Cult. 38 (1): 8-10. Jan. 1976. SFA 21(1).

Construction details are given for a tank system for rearing small groups of salmonid fry from the swim-up stage to a mean weight of up to 15 g. When loading densities were held to 1 kg or less per rearing unit, growth rate, feed conversion, and survival were not affected by overcrowding. Replicated growth trials conducted in these units have produced extremely uniform results. Each unit of the system consists of a circular galvanized steel "mother tank" (92 cm in diameter), with a plywood top fitted for the insertion of five individual 17-liter rearing containers. Water is jetted into a 17-liter head bucket mounted on the plywood top and then introduced into each rearing unit by gravity flow; water level is maintained by means of an inside standpipe. The standpipe is easily removed for cleaning the tank or when the rearing unit is idle.

Cost of materials for constructing a complete 5-bucket rearing unit was \$69 in May 1975.

76-000025 Theis, G. L. (U.S. FWS, Lamar Fish Cult. Dev. Cent., Lamar, PA 16848) MOTORIZED CROWDING SYSTEM FOR HATCHERY RACEWAYS. Prog. Fish-Cult. 38 (1): 46-47. Jan. 1976. SFA 21(1).

A motorized fish crowding system for a standard raceway unit (8 X 100 ft) is described. In operation it takes about 4 1/2 min to crowd fish the length of the raceway to a fish pump intake.

GENERAL LIMNOLOGY AND OCEANOGRAPHY

76-000026 Alexander, V.; Burrell, D. C.; Chang, J.; Cooney, R. T.; Coulon, C.; Crane, J. J.; Dygas, J. A.; Hall, G. E.; Kinney, P. J.; Kogl, D.; Mowatt, T. C.; Naidu, A. S.; Osterkamp, T. E.; Schell, D. M.; Seifert, R. D.; Tucker, R. W. (Inst. Mar. Sci. Univ. Alaska, Fairbanks 99701) ENVIRONMENTAL STUDIES OF AN ARCTIC ESTUARINE SYSTEM--FINAL REPORT. U.S. Environ. Prot. Agency Ecol. Res. Ser. EFA-660/3-75-026. ix + 536p. June 1975. SFA 21(1).

The Colville River estuarine system was studied over a period of four years. Physical, chemical, geomorphological and biological features were included. North slope river deltas differ significantly from those elsewhere, due to climatological extremes and a long, cold, dark winter with continuous ice-cover and continuous daylight during the summer with melting ice or open water. Basic information has been obtained on the winds, waves and currents. Predominant current directions are from the west, with wind drift currents with a

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periodicity of 4 to 5 days. Beach sediments are characterized as poorly sorted gravelly sandy sediment in a relatively low energy environment. The ice-free biological regime is strongly influenced by the river input of low salinity water containing relatively high concentrations of nitrogen nutrients. An annual primary production in the estuary is estimated at 10-15 g-C/m². Crustaceans, molluscs and polychaetes characterize the macrofauna at depths exceeding 2 m, with but few species responsible for most of the biomass. Interesting features of the chemical regime are connected with the isolation of hypersaline water in the shallow estuarine and river system. Fresh water systems were included in the study.

76-000027 Burns, N. M.; Jaquet, J.-M.; Kemp, A. L. W.; Lam, D. C. L.; Leach, J. H.; Munawar, M.; Simons, T. J.; Sly, P. G.; Thomas, R. L.; Watson, N. H. F.; Williams, J. D. H. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) PROCESSES WITHIN LAKE ERIE. J. Fish. Res. Board Can. 33 (3): 639-643. Mar. 1976. In English with French summ. SFA 21(1).

The current level of knowledge concerning Lake Erie is inadequate for the development of a predictive model of the system. Nevertheless, an outline of the submodels required for the development of a predictive model is presented. Further, as a result of many recent studies, the level of understanding of the Lake Erie system has increased immensely and major gaps in the present knowledge of the lake have been identified; useful areas for future research have been indicated. Many of the recent studies on Lake Erie are included in this special issue. The results of these investigations have been summarized and linked together where possible, to describe the lake and give an overview of the more important processes in Lake Erie.

76-000028 Burns, N. M. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) TEMPERATURE, OXYGEN, AND NUTRIENT DISTRIBUTION PATTERNS IN LAKE ERIE, 1970. J. Fish. Res. Board Can. 33 (3): 485-511. Mar. 1976. In English with French summ. SFA 21(1).

Ten major surveys of biological and chemical variables in Lake Erie were carried out during the 1970 shipping season. The observed distributions of temperature, turbidity, oxygen, soluble and particulate phosphorus, nitrate plus nitrite, ammonia, and soluble reactive silica are presented. Comment on the probable causes of the observed distribution patterns has been included where appropriate. Ammonia quantities in the lake remained almost unchanged throughout the year while nitrate plus nitrite quantities varied considerably. The ratio of particulate to total phosphorus showed very little seasonal change.

76-000029 Farguhar, G. B. (Acoust. Proj. Div., Naval Oceanogr. Off., Washington, DC 20373) BIOLOGICAL SOUND SCATTERING IN THE OCEANS: A REVIEW. J. Acoust. Soc. Am. 59 (Suppl. No. 1): 73. 1976. Abstract only. SFA 21(1).

An Office of Naval Research-sponsored conference was held in November 1975 to determine approaches to predicting volume reverberations based upon physicochemical, biological, acoustic, and modeling considerations. Review papers were presented in plenary session for each disciplinary area, after which working groups were convened to assess current understanding, review problems, and prepare recommendations. This paper is the substance of the review given in plenary session on bioacoustic aspects of sound scattering. Biological backscattering is frequency dependent, and varies with depth, time of day, season, and area. Both resonant and nonresonant scattering effects are involved. Gas-filled swimbladders of mesopelagic fishes

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dominate resonant effects, especially at frequencies below about 30 kHz, although these fishes and many others may contribute as well to nonresonant, geometric scattering, depending upon acoustic wavelength. At higher frequencies (40-300 kHz), various zooplankton groups are discernible using single-frequency sources. Column scattering-strength spectra over the range from about 1-20 kHz show definite patterns and variations which are relatable to oceanographically and biologically defined regions in the oceans.

76-000030 Holiday, D. V. (Tracor, Inc., San Diego, CA 92106) IMPACT OF MODERN ACOUSTIC TECHNOLOGY ON THE SCIENTIFIC ASSESSMENT OF MARINE LIFE. J. Acoust. Soc. Am. 59 (Suppl. No. 1): 74. 1976. Abstract only. SFA 21(1).

In recent years significant advances have been made in understanding the effects of the marine environment on the propagation and scattering of sound and in acoustic signal processing. A few of these developments have been used in the study of marine life. Several examples of the uses of underwater acoustics to study life in the sea are examined. Specific topics include studies of plankton and small nekton; investigations and assessments of commercial fish stocks; and studies of marine mammals.

76-000031 Pieper, R. E. (Allan Hancock Found., Univ. South. Calif., Los Angeles 90007) USE OF ECHO SOUNDERS OPERATED AT HIGH ACOUSTIC FREQUENCIES IN THE MARINE ENVIRONMENT AND SOME COMPARISONS WITH OCEANOGRAPHIC PARAMETERS. J. Acoust. Soc. Am. 59 (Suppl. No. 1): 73. 1976. Abstract only. SFA 21(1).

Qualitative and quantitative scattering measurements at high acoustic frequencies were compared to the distributions of zooplankton, nekton, and other oceanographic measurements. Scattering was recorded at 100 and 200 kHz from depths of high euphausiid concentrations. No scattering was recorded at 11 kHz at these depths on some cruises. When scattering was recorded at 11 kHz at the depths of the high-frequency scattering layer, the scattering records were qualitatively different and indicated the presence of fishes within the high-frequency scattering layers. The high-frequency scattering was also often correlated with oceanographic discontinuities such as thermoclines, haloclines, oxyclines, and the chlorophyll maximum. Variations in scattering strengths at the same depth plane were recorded. This patchiness in distribution of scattering at the high frequencies appeared to be correlated with aggregations of euphausiids.

76-000032 Rada, R. G. AN INVESTIGATION INTO THE TROPHIC STATUS OF CANYON FERRY RESERVOIR, MONTANA. Ph.D. dissertation, Mont. State Univ. 139p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

Canyon Ferry Reservoir could be characterized as a bicarbonate water with calcium as its most abundant cation. More inorganic nitrogen was observed in the outflow as compared to the inflow of Canyon Ferry Reservoir. The most logical explanation is nitrogen fixation by the blue-green alga, *Aphanizomenon flos-aquae*, during the summer. The extent of spring drawdown of the reservoir appeared to be a significant factor in the amount of nitrogen recycled to the reservoir each year. Loads of total phosphorus were nearly equal in the inflow and outflow while much of the combined phosphorus that entered the reservoir was converted to ortho-phosphorus which was discharged. Canyon Ferry's deep-water withdrawal allowed it to discharge large loads of inorganic nitrogen and phosphorus which helped alleviate many of the problems associated with high specific surface loading of

SPORT FISHERY ABSTRACTS

76-C00032 CONTINUED

nutrients. The phytoplankton in Canyon Ferry consisted of 65 species and was primarily a blue-green algae/diatom flora. Canyon Ferry could be classified as a moderately productive or slightly eutrophic reservoir. There was no evidence to indicate that the reservoir had become more eutrophic from 1957-1958 to 1971-1972. In fact, it appeared to have become less eutrophic. Canyon Ferry Reservoir lost its high initial level of productivity and appeared to be approaching a lower steady state level of production by 1971-1972. This level of production should continue throughout much of the life of the reservoir. (From Auth. Abstr.)

76-000033 Sly, P. G. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) LAKE ERIE AND ITS BASIN. J. Fish. Res. Board Can. 33 (3): 355-370. Mar. 1976. In English with French summ. SFA 21(1).

The bathymetry of Lake Erie is separated into Western, Central, and Eastern basins, whose form and feature have been strongly influenced by bedrock geology and the effects of Pleistocene events. The climatic regime is mid-continental but is modified by the overall effect of the Great Lakes, mean annual temperatures have a range of about 21 C. European settlement in the basin began in the early 1800s and land use patterns and historic settlement differ distinctly north and south of the lake. Changes in Lake Erie water quality are strongly associated with both agricultural and industrial development, but did not become severe until towards the end of the 1930s. However, changes and depletion of fish stocks likely owe as much to overfishing as to changes in water quality.

76-000034 Taylor, W. W. (Dep. Biol., W. Va. Univ., Morgantown 26506) THE ZOOPLANKTON, ZOOBENTHOS, AND BROOK SILVERSIDE FOOD IN MONCOVE LAKE, WEST VIRGINIA. MS thesis, W. Va. Univ., Morgantown viii + 116p. 1975. SFA 21(1).

Zooplankton and benthic investigations were conducted at Moncove Lake, a 144 acre impoundment in southeastern West Virginia, from August, 1972 through July, 1973. In addition the food habits of the brook silverside, *Labidesthes sicculus*, were studied.

The zooplankton community consisted of six crustacean and nine rotifer species. The dominant crustaceans were *Daphnia ambigua*, *Daphnia catawba*, and *Mesocyclops edax*. The most abundant rotifers were *Keratella cochlearis*, *Ptygura libera*, *Asplanchna priodonta*, *Kellicottia bectoniensis*, and *Conochilus unicornis*. The zooplankton communities of the deep and shallow sections were quantitatively significantly different but not qualitatively.

Qualitatively and quantitatively the dipterans were the most abundant benthic group. They represented six of the thirteen benthic taxons and comprised 86.7 percent of the total benthos. The benthic densities exhibited a distinct relationship to depth with *Chaoborus* and the cyclopoid copepods the only populations which increased in depths greater than three meters.

Labidesthes sicculus smaller than 60 mm depended mainly on cladocerans for their energy. Larger fish decreased their intake of cladocerans and increased their consumption of copepods and insects.

Based on the low densities of the crustacean zooplankton during the growing season, the oligotrophic nature of some of the rotifer species and the benthic trophic condition, Moncove Lake is oligotrophic.

76-000035 Uttormark, P. D.; Wall, J. P. (Water Resour. Cent., Univ. Wis., Madison 53706) LAKE CLASSIFICATION--A TROPHIC CHARACTERIZATION OF WISCONSIN LAKES. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-66-/3-75-033. vi + 165p. June. 1975. SFA 21(1).

The design and application of the Lake Condition Index (LCI) system of classifying lakes is described, and it is demonstrated that lake classification can be employed as a useful tool by resource managers for comparing the trophic condition of large numbers of lakes. The LCI system was generated when an evaluation of other systems revealed that most are presently unsuitable for classifying the vast majority of lakes because the analytical data required for their use are lacking. Utilizing subjective information, the LCI system was applied to the classification of more than 1100 large Wisconsin lakes. Checks of the results show that 86 percent of the lakes were appropriately classified within the limits of the system; 14 percent were misclassified, as judged by individuals familiar with the lakes in question. Most, but not all, discrepancies were due to erroneous input data.

The LCI values obtained were coupled with nutrient-loading considerations and shoreline density-development factors to demonstrate that lake classification can serve as a workable data base for lake reevaluation and management programs. The LCI system is easily modified to incorporate additional data for special purposes. The system could be used to classify an estimated 70-80 percent of the larger lakes in the United States.

PHYSICAL LIMNOLOGY AND OCEANOGRAPHY

76-000036 El-Sabbh, M. I. (Sect. Oceanogr., Univ. Quebec, Rimouski, PQ, Canada) SURFACE CIRCULATION PATTERN IN THE GULF OF ST. LAWRENCE. J. Fish. Res. Board Can. 33 (1): 124-138. Jan. 1976. In English with French summ. SFA 21(1).

Using all available oceanographic data in the Gulf of St. Lawrence between 1950 and 1969, a network of average stations was formed for the months of June, July, August, November, and for the winter period. The dynamic method was applied to calculate the geostrophic circulation in the Gulf during these months based on a variable reference layer.

The main features of the reference layer are the steep slope along the Gaspé coast and the existence of three depressions in the Laurentian Channel, southeast and west of Anticosti Island, and in the central region of Cabot Strait. Its depth varies from 10 to 50 m in the Magdalen Shallows to more than 300 m in part of the Laurentian Channel. The general two-way flow in all entrances to the Gulf, the existence of a permanent anticlockwise gyre west of Anticosti Island, and the Gaspé and Cape Breton currents with which are associated the highest velocities in the Gulf are the main features of the circulation pattern. The circulation patterns obtained agree with the results of synoptic observations.

Cyclonic and anticyclonic gyres are common to the Gulf. A comparison of the circulation patterns obtained in this study and the results of the International Biological Programme Study of the Gulf reveal that such cyclonic and anticyclonic gyres are responsible, at least in part, for the areas of maximum primary productivity west and northeast of Anticosti Island, and for the so-called "desert areas" in the northeastern side of the Gulf.

76-000037 Garrett, C. J. R.; Loucks, R. H. (Dep. Oceanogr., Dalhousie Univ., Halifax, NS, Canada) UPWELLING ALONG THE YARMOUTH SHORE OF NOVA SCOTIA. J. Fish. Res. Board Can. 33 (1): 116-117. Jan. 1976. In English with French summ. SFA 21(1).

Coastal upwelling seems to occur off the southwestern shore of Nova Scotia. It is suggested that this may be driven by centrifugal forces associated with the strong tidal currents past the convex coastline, in much the same way as secondary circulation is generated for river flow round a bend.

76-000038 Ingraham, W. J., Jr.; Hastings, J. R. (NMFS, 2725 Montlake Blvd. East, Seattle, WA 98112) SEASONAL SURFACE CURRENTS OFF THE COASTS OF VANCOUVER ISLAND AND WASHINGTON AS SHOWN BY DRIFT BOTTLE EXPERIMENTS, 1964-65. NOAA Tech. Rep. NMFS SSRF-699. iii + 9p. May 1976. SFA 21(1).

Release of a total of 1,044 drift bottles during four periods from April 1964 to January 1965 off the coasts of Washington and Vancouver Island, British Columbia, indicate a seasonal reversal of flow, southward in April and July and northward in November and January, within 200 km (108 nautical miles) of the coast. This study supplements those conducted off the Oregon and California coasts by other agencies.

76-000039 Kirchner, W. B. (Dep. Zool., Univ. Toronto, Toronto, ON N5S 1A1, Canada) AN EVALUATION OF SEDIMENT TRAP METHODOLOGY. Limnol. Oceanogr. 20 (4): 657-660. July 1975. SFA 21(1).

Five sediment traps with collecting areas ranging from 8 to 1,465 cm² collected the same amount of material, as measured by dry weight, ash weight, and phosphorus content, on a unit area basis. Variances from different size traps were not significantly different. These results are presented as further illustration that traps are a meaningful technique for measuring sedimentation in certain lakes.

76-000040 Simons, T. J. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) CONTINUOUS DYNAMICAL COMPUTATIONS OF WATER TRANSPORTS IN LAKE ERIE FOR 1970. J. Fish. Res. Board Can. 33 (3): 371-384. Mar. 1976. In English with French summ. SFA 21(1).

A numerical model of Lake Erie has been used to compute water transports throughout the 1970 shipping season on the basis of continuous wind observations from six shore stations. A vertically integrated model was used for quasi-homogeneous conditions, and a two-layer model was employed to simulate summer stratification. The computed water circulations were retained for a study of the horizontal distribution of various chemical parameters measured by regular ship cruises on the lake during this period. Computed surface elevations were compared with observed water level data to verify the model calculations and to adjust the windstress coefficient from month to month. The coefficient of correlation between observed and computed Buffalo-minus-Toledo water setup averages out to .95 for the complete integration period. In addition, a comparison was made of model results and available data from current meters maintained in the lake during this period. The results show the feasibility of quasi-operational applications of a model of the present type for computing the necessary water transport information for ecosystems modeling and water resources planning.

76-000041 Sutcliffe, W. H., Jr.; Loucks, R. H.; Drinkwater, K. F. (Fish. Mar. Serv., Bedford Inst. Oceanogr., Dartmouth, NS B2Y 4A2, Canada) COASTAL CIRCULATION AND PHYSICAL OCEANOGRAPHY OF THE SCOTIAN SHELVE AND THE GULF OF MAINE. J. Fish. Res. Board Can. 33 (1): 98-115. Jan. 1976. In English with French summ. SFA 21(1).

Correlations between annual catch of coastal commercial species of fish and the environmental factors of sea temperatures and St. Lawrence River discharge have led to an investigation of the relationship between the latter. Examining year-to-year variability of monthly means, effects of the St. Lawrence River discharge can be traced by correlation analysis with sea temperatures to propagate from the Gulf of St. Lawrence onto the Scotian Shelf and through the Gulf of Maine at known coastal current drift speeds. Seasonal salinity and transport data support such a flow at least to a section off Halifax on the Scotian Shelf. Within the Gulf of Maine seasonal salinities do not support continuity of flow; however, possible reasons and mechanisms for this are discussed. Other factors such as local river runoff in the Gulf of Maine, Labrador Current, and large-scale weather systems are briefly considered and discussed. It is proposed that the Gulf of St. Lawrence to the Gulf of Maine inclusive be considered as an oceanographic system and events occurring in the southern part on time scales of a month or more are not independent of more northerly events. It is not interpreted that the river discharge is the driving force of such an oceanographic system but rather influences the water properties within the source region of the flow, i.e. the Gulf of St. Lawrence. Some biological implications of the Gulf of St. Lawrence to Gulf of Maine pathway are pointed out.

CHEMICAL LIMNOLOGY AND OCEANOGRAPHY

76-000042 Bella, D. A. (Dep. Civ. Eng., Oreg. State Univ., Corvallis 97331) TIDAL FLATS IN ESTUARINE WATER QUALITY ANALYSIS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-025. x + 186p. June 1975. SFA 21(1).

This report summarizes the results of a research project entitled "Tidal Flats and Estuarine Water Quality Analysis." The initial phases of the study involved mixing processes and tidal hydraulics, however, the study emphasis shifted to estuarine benthic systems as the importance of these systems became more apparent. The sulfur cycle was given particular emphasis because:

- (1) sulfides, resulting from sulfate reduction within the benthic systems, can influence the benthic oxygen uptake rate,
- (2) free sulfides are highly toxic to a variety of organisms, and
- (3) the release of hydrogen sulfide may contribute to a deterioration of air quality.

The sulfur cycle is of particular importance in tidal estuaries because of the high sulfate concentrations of saline waters in comparison to fresh waters. A conceptual model of estuarine benthic systems was developed and a classification system of estuarine benthic deposits which is based on the availability of hydrogen acceptors and reactive iron was developed.

Field studies demonstrated that estuarine waters overlying organic rich tidal flat deposits could contain significant concentrations of free sulfides even when dissolved oxygen was present. Field studies of benthic oxygen uptake and benthic sulfide release were conducted. Water quality profiles within the deposits were also determined. A number of laboratory studies were conducted to determine the rate of sulfate reduction. Results from experiments using extracts from benthic deposits and algal mats demonstrated a close relationship between the rate of sulfate reduction and the sulfate and soluble

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organic carbon concentrations. A general systems model of estuarine benthic systems was developed, however, specific definition of all processes was not possible without further experimental results. A variety of activities which could contribute to significant environmental changes with estuarine benthic systems were identified.

Methods of determining dispersion coefficients from salinity profiles were examined and an improved method was developed. The build-up of a pollutant in the vicinity of the outfall during the slack water period of the tide was studied through a field experiment and mathematical model study.

76-000043 Burns, N. M.; Nriagu, J. O. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) FORMS OF IRON AND MANGANESE IN LAKE ERIE WATERS. J. Fish. Res. Board Can. 33 (3): 463-470. Mar. 1976. In English with French summ. SFA 21(1).

About 95 percent of the iron observed in the lake water is bound to inorganic particles and is present in the water because of sediment resuspension. Contrary to popular belief, the upwelling of interstitial waters charged with ferrous iron does not appear to play an important part in the regeneration of iron from Lake Erie sediments except when anoxic conditions exist at the sediment-water interface. By contrast, manganese is usually found in the overlying water as a result of the release of interstitial water containing dissolved manganese. This precipitates in oxygenated water so that most of the manganese present in the water is found in the particulate form. However, the released manganese will remain soluble if the oxygen saturation is less than 50 percent. In general, it was found that both the iron and manganese were in the particulate or soluble form in accordance with the geochemical solubility rules.

76-000044 Burns, N. M.; Williams, J. D. H.; Jaquet, J.-M.; Kemp, A. L. W.; Lam, D. C. L. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) A PHOSPHORUS BUDGET FOR LAKE ERIE. J. Fish. Res. Board Can. 33 (3): 564-573. Mar. 1976. In English with French summ. SFA 21(1).

A budget for phosphorus retention in Lake Erie during 1970 has been drawn up. Phosphorus associated with sand-sized particles (greater than 63 μ m) was excluded. Retention of apatite phosphorus (AP) and nonapatite phosphorus (NAP) within each of the three basins of the lake (Western, Central, and Eastern) was estimated in each case by two independent methods. The two estimates of retention of total phosphorus within the entire lake agreed to within 9.5 percent of their mean. The estimates of AP retention within the Western basin also agreed well. However, the input-output balance estimates of AP retention in the Central basin and of NAP retention in the Western and Central basins greatly exceeded the corresponding sedimentation values, while in the Eastern basin this pattern was reversed. The AP discrepancy was attributed to unobserved transport of AP from the Central to the Eastern basin via nearshore currents past Long Point, while the NAP discrepancies were largely attributed to eastward movement of NAP through the lake within about 2 m of the lake bottom. The total amount of phosphorus retained within the lake in 1970 was 41,000 metric tons, or about 92 percent of input. AP of natural origin and inert nature accounted for approximately 44 percent of the total phosphorus retained. A reduction in anthropogenic phosphorus input of about 15,000 metric tons/yr. as called for in the Great Lakes Water Quality Agreement, will reduce present annual NAP loading to close to pre-1850 values.

SPORT FISHERY ABSTRACTS

76-000045 Burns, N. M. (Canada Cent. Inland Waters, Burlington, CN L7R 4A6, Canada) NUTRIENT BUDGETS FOR LAKE ERIE, 1970. J. Fish. Res. Board Can. 33 (3): 520-536. Mar. 1976. In English with French summ. SFA 21(1).

Budgets for the quantities of water, chloride, and phosphorus entering and leaving Lake Erie during the year of 1970 have been developed. The phosphorus budget was broken down into basin budgets which were further subdivided into epilimnion budgets for the Central and Eastern basins. Epilimnion budgets for soluble inorganic nitrogen (SIN) and soluble reactive silica (SRS) were also developed. The average coefficients of elimination by sedimentation of the phosphorus within each basin were 4.0, 0.38, and 0.18 percent/day for the Western, Central, and Eastern basins, respectively. The phosphorus elimination was found to be inversely related to mean basin depth but directly related to the phosphorus concentration of the water. The epilimnion budgets showed that during the summer the internal loading of SRS to the epilimnion was greater than the uptake of SRS by phytoplankton growth. The epilimnion budget of SIN demonstrated a massive uptake of the material during the summer, which was only partially replenished. The loss rate of phosphorus from the Central and Eastern basin epilimnia decreased as the summer progressed, to the extent that there was a net gain of phosphorus in the Eastern basin epilimnion toward the end of the summer. It is believed that this resulted from significant upward transport of phosphorus from the hypolimnion to the epilimnion by flagellate species of phytoplankton.

76-000046 Burns, N. M. (Canada Cent. Inland Waters, Burlington, CN L7R 4A6, Canada) OXYGEN DEPLETION IN THE CENTRAL AND EASTERN BASINS OF LAKE ERIE, 1970. J. Fish. Res. Board Can. 33 (3): 512-519. Mar. 1976. In English with French summ. SFA 21(1).

The hypolimnetic oxygen depletion rate is required to be measured to an accuracy of approximately 3 percent if major changes in the trophic state of Lake Erie are to be documented within about 5 yr of the change commencing. Depletion rate measurements of this level of accuracy require a knowledge of reoxygenation of the Central and Eastern basin hypolimnia and the transport of oxygen between the hypolimnia. A model is described here that enables an estimate of the degree of hypolimnetic reoxygenation to be made. The transport of oxygen between the hypolimnia was estimated by means of a hydrodynamic model. The resultant calculations gave areal hypolimnetic depletion rate values of 0.43 and 0.87 g O₂ /m²/day for the Central and Eastern basins, respectively, and volumetric depletion rates of 0.13 and 0.057 g O₂ /m³/day, respectively, for these basins during 1970.

76-000047 Dillon, P. J. (Ontario Minist. Environ., Water Resour. Br., Resources Bd., Box 213, Rexdale, ON, Canada) THE PHOSPHOROUS BUDGET OF CAMERON LAKE, ONTARIO: THE IMPORTANCE OF FLUSHING RATE TO THE DEGREE OF EUTROPHY OF LAKES. Limnol. Oceanogr. 20 (1): 28-39. Jan. 1975. SFA 21(1).

The total phosphorus budget of Cameron Lake is described for two 12-month periods. Although the phosphorus loadings were high (1.70 and 2.21 g/m²/yr), the lake is not eutrophic because a high flushing rate counteracts the high loading. A plot of $L/(1-R)/\rho$, where L is phosphorus loading, R is the retention coefficient of phosphorus in the lake, and ρ is the hydraulic flushing rate, vs. $[Z]$, the mean depth, is suggested as a means of relating lake trophic state to phosphorus loading. This formulation accurately predicted that nearby Four Mile Lake would be almost identical to Cameron Lake in terms of degree of eutrophy despite the fact that Four Mile Lake's phosphorus load is 20 times less than that of Cameron Lake.

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76-000048 Fish, G. R. (N. Z. Minist. Agric. Fish., Wellington, New Zealand) A NUTRIENT BUDGET FOR LAKE ROTORUA. N. Z. Minist. Agric. Fish. Fish. Res. Publ. No. 242. 9p. 1975. SFA 21(1).

76-000049 Ho, C. L.; Barrett, B. B. (La. Wildl. Fish. Comm., 400 Royal St., New Orleans 70130) DISTRIBUTION OF NUTRIENTS IN LOUISIANA'S COASTAL WATERS INFLUENCED BY THE MISSISSIPPI RIVER. La. Wildl. Fish. Comm. Tech. Bull. No. 17. xi + 39p. Aug. 1975. SFA 21(1).

The volume of freshwater introduced into Louisiana's coastal zone during 1973, both by rainfall and river discharge, was the highest recorded since 1940. Selected nutrients (ammonium-N, [nitrate + nitrite]-N, phosphate-P, and dissolved silicate), organic-N, and salinity were measured in Louisiana coastal waters from the mouth of the Mississippi River to Caminada Bay during four sampling trips in 1973. Three of these sampling trips coincided with high river discharge, and the last sampling effort occurred during low river discharge. Resultant data showed the tremendous influence of the Mississippi River on nutrient concentrations in the coastal waters adjacent to the river mouth. River waters contributed large amounts of NO(3)-, dissolved SiO(2), PO(4)-3, and organic-N to the Gulf of Mexico. Waters in the upper estuaries of Caminada and Barataria Bays were characterized by high NH(4)+ levels relative to the nearshore waters. During the low discharge period of the Mississippi River, nearshore waters were dominated by nutrient depleted seawater. Inorganic nutrients and organic-N levels in the bays and adjacent nearshore waters were higher than at the river mouth during the low discharge period. The primary source of nutrients to the bays during low river discharge is the surrounding marshes. The estimated combined weight of NO(3)- + NO(2)-N, PO(4)-3-P, dissolved SiO(2), organic-N, and organic-C emptied into the Gulf by the Mississippi River between January and July 1973 was 12.9 billion kilograms (28.4 billion pounds). Nutrient contribution by the Mississippi River undoubtedly accounts for the high production of fisheries in this region of the Gulf.

76-000050 Kemp, A. L. W.; Thomas, R. L.; Dell, C. I.; Jaquet, J.-M. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) CULTURAL IMPACT ON THE GEOCHEMISTRY OF SEDIMENTS IN LAKE ERIE. J. Fish. Res. Board Can. 33 (3): 440-462. Mar. 1976. In English with French summ. SFA 21(1).

The chemical and physical characteristics of six cores from Lake Erie are described. The concentrations of Si, Al, K, Na, and Mg, which represent the major mineral species in the sediment, were uniform in each core. Surface enrichments of Hg, Pb, Zn, Cd, Cu, Organic-C, N, and P were observed at each location, due mainly to the increasing anthropogenic loading of these elements to the sediments since 1850. Concentration profiles for Mn, Fe, and S were related to sediment Eh and are due to mobilization of these elements in the pore waters.

Natural and anthropogenic inputs of nutrients and heavy metals were calculated. About 60 percent of the total loading of these elements is being deposited in the Eastern basin. It is calculated that 30 million metric tons of fine-grained sediment accumulates in the offshore basins of the lake, each year. The major source of the sediment input is erosion of the shoreline bluffs, with the north shore between Eriau and Long Point contributing 21 million metric tons annually. A sediment mass balance suggests that a large part of this bluff material is transported up to 150 km and is deposited in the Eastern basin.

76-000051 Lam, D. C. L.; Jaquet, J.-M. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) COMPUTATIONS OF PHYSICAL TRANSPORT AND REGENERATION OF PHOSPHORUS IN LAKE ERIE, FALL 1970. J. Fish. Res. Board Can. 33 (3): 550-563. Mar. 1976. In English with French summ. SFA 21(1).

A one-layer, two-dimensional computer model for the time-dependent, lakewide advective and diffusive transports as well as physical regeneration of total phosphorus in Lake Erie has been developed. It has 60 x 16 square grid cells of 6.67-km mesh size and uses a time step of 12 h. The model has been verified and found to be in reasonably good agreement with the Canada Centre for Inland Waters (CCIW) monitor cruise data for October, November, and December during which period there were high winds with high phosphorus concentrations being observed. Computed, daily averaged currents from a hydrodynamic model developed at CCIW are used for the transport terms and actual data for the lake boundary conditions. The physical regeneration is attributed to wave motions induced by wind. A formula is proposed which expresses the regenerated amount of total phosphorus in terms of wave orbital velocity and sediment mean grain size. A discussion is presented on the choice of the settling rate and the regeneration coefficient which produce satisfactory model results.

76-000052 Lam, D. C. L.; Simons, T. J. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) NUMERICAL COMPUTATIONS OF ADVECTIVE AND DIFFUSIVE TRANSPORTS OF CHLORIDE IN LAKE ERIE, 1970. J. Fish. Res. Board Can. 33 (3): 537-549. Mar. 1976. In English with French summ. SFA 21(1).

This paper is concerned with a numerical simulation of lakewide advective and diffusive transports of conservative pollutants or nutrients, such as chloride, in Lake Erie. The study is a continuation of a hydrodynamic modeling experiment to compute water circulations throughout the 1970 shipping season, also in this issue, and makes use of ship observations of chloride distributions at approximately 4-wk intervals during 1970, together with estimates of river loadings for the same periods.

The model equations are based on the time-dependent, mass-conserving advection-diffusion equation. A vertically mixed, one-layer, two-dimensional model is employed for spring and fall, whereas a two-layer model is used to simulate the stratified lake in summer. The equations are solved by finite-difference formulations on a horizontal grid with a mesh size of 6.67 km. Using time steps of 6 h, predictions are made of the change of chloride concentrations between pairs of cruises and the results are compared with observations.

While the advective currents are derived from the previous hydrodynamic study, diffusion coefficients are estimated by comparing model results for a range of coefficients. The resulting numerical values compare favorably with findings of diffusion experiments in actual lake environments.

76-000053 Lasenby, D. C. (Dep. Biol., Trent Univ., Peterborough, ON K9J 7B8, Canada) DEVELOPMENT OF OXYGEN DEFICITS IN 14 SOUTHERN ONTARIO LAKES. Limnol. Oceanogr. 20 (6): 993-999. Nov. 1975. SFA 21(1).

Areal hypolimnetic oxygen deficits in 14 southern Ontario lakes developed linearly throughout summer in 13 of the lakes and decreased, usually linearly, as the upper limit of the hypolimnion was chosen at successively greater depths. Areal hypolimnetic oxygen deficit ranged from 0.006 to 0.041 mg/cm²/day; to the -1; it was not correlated with average dry weight of seston in summer but was correlated with average Secchi depth during summer.

76-000054 Lasheen, M. R. M. W. FACTORS INFLUENCING METAL UPTAKE AND RELEASE BY SEDIMENTS IN AQUATIC ENVIRONMENTS. Ph.D. dissertation, Univ. Mich. 138p. 1974. From Diss. Abstr. Int. E Sci. Eng. 35(11), 1975. SFA 21(1).

Sediments and suspended matter play a significant role in the overall distribution of trace metals in the aquatic environments. It has been shown that bottom sediments act as sinks for metals of natural and pollutional origin. This study was designed to elucidate the factors affecting the capacity and rate of metal uptake and release by sediments. This includes organic complexing agents of natural and pollutional origin, pH, and competitive interactions with alkaline earth metals. Three trace metals, cadmium, lead and copper, were chosen for this investigation since they are toxic to aquatic biota and are hazardous to human health. The effects of organic matter such as glycine, humic acid, NTA, EDTA and secondary sewage effluent were studied. These compounds were chosen on the basis of their prevalence as pollutants and their complexing characteristics. Metal uptake and release by montmorillonite clay minerals were determined. The sediment size fraction used was less than 2 μ . (From Auth. Abstr.)

76-000055 Ongley, E. D. (Dep. Geogr., Queens Univ., Kingston, ON, Canada) SEDIMENT YIELDS AND NUTRIENT LOADINGS FROM CANADIAN WATERSHEDS TRIBUTARY TO LAKE ERIE: AN OVERVIEW. J. Fish. Res. Board Can. 33 (3): 471-484. Mar. 1976. In English with French summ. SFA 21(1).

Mean annual loadings and unit yields for sediment, phosphorus, nitrogen, and chloride have been calculated for 19 river-mouth locations on the Canadian side of Lake Erie for the period 1967-72. Data, drawn from routine monitoring data files of Federal and Provincial agencies, are discussed in terms of biases inherent in such monitoring programs. Unit yields are only marginally related to basin substrate texture but show pronounced storage characteristics within basins for sediment and sediment-bound nutrients. It is suggested that there is a minimum threshold size of basin below which nutrient runoff is relatively unaffected by basin storage and uptake.

76-000056 Rudd, J. W. M.; Hamilton, R. D. (Dep. Microbiol., Univ. Manitoba, Winnipeg, MB R3T 2M7, Canada) TWO SAMPLERS FOR MONITORING DISSOLVED GASES IN LAKE WATER AND SEDIMENTS. Limnol. Oceanogr. 20 (5): 902-906. Sept. 1975. SFA 21(1).

An in situ vertical point sampler was used over several months to obtain dissolved gas samples from precise and reproducible points in the water column of a stratified lake. Sampling error of the apparatus was negligible.

A sediment gas sampler monitors concentrations by equilibration of dissolved pore water gases with water inside plastic sample tubing, eliminating the problems of degassing and air contamination inherent to other sediment sampling systems. It is simple to construct and operate, enables close interval sampling across the sediment-water interface and causes minimal disturbance of sediments and concentration gradients.

76-000057 Sonzogni, W. C. EFFECT OF NUTRIENT INPUT REDUCTION ON THE EUTROPHICATION OF THE MADISON LAKES. Ph.D. dissertation, Univ. Wis. (Madison) 1974. From Diss. Abstr. Int. B Sci. Eng. 35(11), 1975. SFA 21(1).

The effect of nutrient loading reductions on the limnologically famous Madison lakes has previously received little attention. Since a major diversion of sewage effluent from the lower Madison lakes occurred about fifteen years ago, the long term effect of this diversion could be considered. In addition, a recent waste water diversion from Lake Mendota, the headwater lake in the Madison chain, provided the opportunity to follow the short term response to a reduced nutrient input and to obtain nutrient mass data useful for modeling lake restoration.

Based on a review of current and historical data, phosphorus concentrations were reduced rapidly and permanently within the two lower Madison lakes, Waubesa and Kegonsa, when sewage effluent was diverted (1958) from entering them. This indicated that the sediments of these lakes were not the major factor controlling the phosphate concentration in the water and that the internal phosphorus inputs to these lakes were small compared to the external inputs.

Nutrient loadings were estimated for each of the Madison lakes. The 1971 sewage diversion around Lake Mendota was estimated to have reduced the average annual phosphorus loading by about 20 percent. The Yahara River was found to be the greatest phosphorus source for the lower Madison lakes.

Annual phosphorus and nitrogen cycles in Lake Mendota observed for a three-year period did not indicate any response to the 1971 sewage diversion around the lake. The effect of the 1971 diversion was likely obscured by year-to-year variations in loadings from other nutrient sources, such as runoff. The amount of phosphorus washed into the lake during the spring runoff event of 1973 was particularly large. A massive diatom bloom after ice out (1971) resulted in the largest short term nutrient mass fluctuation during the study.

Internal sources caused a significant increase in the nutrient content of the lake during the stratified period. Phosphorus accumulation rates per unit area of anoxic sediment in Lake Mendota were computed and found to be similar to the rates for other eutrophic lakes. Despite phosphorus release from the sediments during stratification, the sediments served as a phosphorus sink on an annual basis.

A review of the historical data provided no unambiguous evidence that phosphorus levels have increased in Lake Mendota over the years. Possible future changes in quality of the Madison lakes were considered. (From Auth. Abstr.)

76-000058 Thomas, R. L.; Jaquet, J.-M. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) MERCURY IN THE SURFICIAL SEDIMENTS OF LAKE ERIE. J. Fish. Res. Board Can. 33 (3): 404-412. Mar. 1976. In English with French sum. SFA 21(1).

In 259 samples of the topmost 3 cm of sediment taken from Lake Erie in 1971, total mercury values ranged from 8 to 2929 ppb (mean 582 $\pm$ 555 ppb SD). The highest levels were in the Western basin adjacent to the Detroit River, the rest of the lake showing increasing concentration from the coarser sediments of the Inshore Zone and cross-lake moraine sills out into the basin muds. A quartz correction was applied to compensate for texture and dilution by an inert constituent. The distribution of quartz-corrected mercury confirmed that the Detroit River is the predominant source of industrial mercury to the Western basin with subsequent transport across the Central basin to final sink in the Eastern basin. Further possible inputs were indicated from Erie, Pennsylvania and Buffalo, New York. Analysis of suspended sediment in the Detroit River showed no change in

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concentration between 1970 and 1974 with a mean 1974 level of 1060 ppb. Mercury loading was estimated at 7.2 m.t./yr to the sediments of the Western basin. A relationship was observed between total mercury and organic carbon, showing two distinct regressions: 'A' with lower organic-bound mercury, is taken to represent the levels related to industrial and natural loadings existing prior to the introduction of mercury cell chlor-alkali plants; 'B' applicable to highly contaminated sediments, is believed to be indicative of loadings derived from the chlor-alkali industry.

76-000059 Vitousek, P. M. THE REGULATION OF ELEMENT CONCENTRATIONS IN MOUNTAIN STREAMS IN THE NORTHEASTERN UNITED STATES. Ph.D. dissertation, Dartmouth Coll. 149p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(4), 1975. SFA 21(1).

Concentrations of elements in streamwater were monitored in fifty-seven watersheds located along elevational and successional gradients in the White Mountains of New Hampshire. Concentrations of chloride and sulfate decreased with increasing elevation as a result of differences in relative evapotranspiration along the elevation gradient. Concentrations of sodium, calcium, and magnesium also decreased with increasing elevation, but with a steeper slope. Rock weathering/unit of water flux as well as relative evapotranspiration controls concentrations of these cations. Potassium and nitrate concentrations were highly variable, both seasonally within a stream and among streams. Differences among watersheds in terms of successional status are important in controlling nitrate and potassium concentrations. Streams draining old aged forested ecosystems had higher concentrations of nitrate, potassium, and other plant nutrients than did streams draining intermediate aged successional ecosystems at the same elevation. Nine spruce-fir watersheds which have no record of logging or other extensive human disturbance had streamwater nitrate concentrations averaging 53 microequivalents/liter. Five other spruce-fir watersheds which had been logged 30 years previously had streamwater nitrate concentrations averaging 8 microequivalents/liter.

The major factors controlling streamwater concentrations of elements in these watersheds are factors related to supply (precipitation chemistry, relative evapotranspiration, rock weathering) and to plant accumulation of nutrients. Successional ecosystems accumulate nutrient elements and, consequently, have nutrient outputs less than inputs. Rapidly growing successional ecosystems can accumulate a large fraction of inputs of nutrient elements, particularly during the growing season. Steady state ecosystems, those with no new biomass accumulation, have nutrient outputs equal to nutrient inputs. Variations in element outputs during ecosystem development are therefore inversely proportional to element accumulation in the net ecosystem productivity of these watershed ecosystems. The increased losses of nutrient elements from clearcut watersheds in New Hampshire (Likens /et al./, 1970, Pierce /et al./, 1972) can be explained in these terms. Clearcut or otherwise disturbed ecosystems may have decomposition and mineralization in excess of plant uptake, leading to element outputs in excess of inputs. Field experiments demonstrated that the prevention of plant uptake by root trenching led to soil nitrate concentration comparable to those observed in streamwater in the clearcut watershed at Hubbard Brook Experimental Forest (Likens /et al./, 1970).

76-000060 Williams, J. D. H.; Jaquet, J.-M.; Thomas, R. L. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) FORMS OF PHOSPHORUS IN THE SURFICIAL SEDIMENTS OF LAKE ERIE. J. Fish. Res. Board Can. 33 (3): 413-429. Mar. 1976. In English with French summ. SFA 21(1).

The phosphorus in 48 surficial Lake Erie sediment samples was present in three major forms: phosphorus associated with apatite, nonapatite inorganic phosphorus (NAIP), and organic phosphorus. The apatite was of natural, detrital origin. It existed as particles ranging from fine sand to clay in size but mostly as silt-sized particles and was concentrated in nearshore sediments. Both NAIP and organic phosphorus was concentrated in fine-grained sediments accumulating in offshore depositional areas. NAIP was associated with amorphous hydrated ferric oxide in the oxidized microzone but was present as vivianite ($\text{Fe}(3)(\text{PO}(4)) (2) \times 8\text{H}(2)\text{O}$) and possibly other forms also in the reduced zone. The organic phosphorus content of the sediment was closely related to organic carbon content. The phyllosilicate, organic matter, and reactive iron and manganese components of the sediments existed in intimate association.

76-000061 Williams, J. D. H.; Murphy, T. P.; Mayer, T. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) RATES OF ACCUMULATION OF PHOSPHORUS FORMS IN LAKE ERIE SEDIMENTS. J. Fish. Res. Board Can. 33 (3): 430-439. Mar. 1976. In English with French summ. SFA 21(1).

Six Lake Erie sediment cores from locations of widely different sedimentation rates show that rate of input and sedimentation of apatite phosphorus at a given locality has been approximately constant during the last few hundred years relative to total sedimentation rate at the same locality. Apatite is not a significant source of soluble phosphorus for Lake Erie. By contrast, rate of sedimentation of nonapatite inorganic phosphorus (NAIP) and organic phosphorus has steadily increased in accordance with increased loadings in recent years of the source material, namely phosphorus of anthropogenic origin. The rate of sedimentation of these two forms of phosphorus at a given locality varied greatly within the lake, and was greatest where the most fine-grained sediments were accumulating. It was concluded that the sediments of Lake Erie contain sufficient orthophosphate-retaining sites to prevent major regeneration of phosphate under any conceivable condition provided the overlying water remainsoxic.

BENTHOS

76-000062 Dickinson, J. J.; Carey, A. G., Jr. (Sch. Oceanogr., Oreg. State Univ., Corvallis 97331) A COMPARISON OF TWO BENTHIC INFAUNAL SAMPLERS. Limnol. Oceanogr. 20 (5): 900-902. Sept. 1975. SFA 21(1).

The sampling efficiencies of a 0.1-m^2 Smith-McIntyre grab and a deep-sea, anchor-box dredge were compared by determining estimates of faunal density and composition. The two samplers did not differ significantly in their description of the relative abundance of the fauna, but the grab sampler gave estimates of faunal density five times as large as the anchor-box dredge.

76-000063 Gale, W. F.; Thompson, J. D. (Ichthyological Assoc., R.D. 1, Berwick, PA 18603) AIDS TO BENTHIC SAMPLING BY SCUBA DIVERS IN RIVERS. *Limnol. Oceanogr.* 19 (6): 1004-1007. Nov. 1974. SFA 21(1).

A submersible raft transports samples and sampling gear between a boat and the river bottom. Another device aids movement of SCUEA divers across stony substrates.

76-000064 Hendrix, P. F.; Parker, N. C.; Miller, N. A. (Dep. Biol., Memphis State Univ., Memphis, TN 38152) AN INEXPENSIVE CORE SAMPLER FOR LAKE DEPOSITS. *Am. Midl. Nat.* 94 (1): 223-226. July 1975. SFA 21(1).

Details are given for the construction and operation of a simple, inexpensive core sampler for lake deposits. It features a self-contained pile-driving weight, a ball check valve, and interchangeable sampler tubes of various lengths.

76-000065 Hildebrand, S. G. (Sch. Nat. Resour., Univ. Mich., Ann Arbor 48104) THE RELATION OF DRIFT TO BENTHOS DENSITY AND FOOD LEVEL IN AN ARTIFICIAL STREAM. *Limnol. Oceanogr.* 19 (6): 951-957. Nov. 1974. SFA 21(1).

The relationship between drift rates, benthos density, and food level for select taxa of stream invertebrates was studied in an artificial stream system to determine if drift is independent of or dependent on population density, and if food level affects drift rates. Two taxa were introduced in a range of densities at a single level of periphyton food, and the drift from each density was measured. Four taxa were introduced in a range of densities at low and high food levels, and the drift from each density at each food level was measured. The drift of all taxa, examined by simple linear regression analysis, at each food level was judged a density independent response to increasing population density. The drift of three taxa at a given density was significantly greater at the lower food level: it is suggested that increased activity in searching for food at the lower food level resulted in increased drift.

76-000066 Hilsenhoff, W. L. (Dep. Entomol., Univ. Wis., Madison 53706) AQUATIC INSECTS OF WISCONSIN. GENERIC KEYS AND NOTES ON BIOLOGY, ECOLOGY AND DISTRIBUTION. *Wis. Dep. Nat. Resour. Tech. Bull.* No. 89. 52p. 1975. SFA 21(1).

The most recent keys to genera of aquatic insects in North America appear in Pennak (1953), Usinger (1956), and Edmundson (1959), but many taxonomic advances have been made since their publication. Increased interest in the aquatic environment has led to a demand for up-to-date keys to aquatic insects. I have attempted to fill that demand by providing generic keys to aquatic insects that occur in Wisconsin. These keys are restricted to genera that are likely to be found in Wisconsin, and treat only aquatic stages of those genera. The regional scope of the keys eliminates many genera that occur only in distant parts of North America, thus simplifying their use. Although the keys are intended for use in Wisconsin, they should also be applicable for neighboring states.

General information on the biology, ecological requirements, and distribution and abundance of genera in Wisconsin is also included. Appended to each key is a list of species that occur in Wisconsin; species and genera that may occur but have not yet been collected are marked with an asterisk. References to the most recent keys to species that are not monotypic are also included for most of the orders. Because of many uncertainties in identification, no list of species is appended for Diptera, Lepidoptera, or Neuroptera, and no effort has been made to denote by asterisks which species of Ephemeroptera have

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not been collected in Wisconsin. (Auth. Intro.)

76-000067 Mason, W. T., Jr. (Water Qual. Serv., Interstate Comm. Potomac River Basin, Suite 800, 4350 East West Highway, Bethesda, MD 20014) PORTABLE, HAND-OPERATED CYCLE SIEVE FOR WASHING MACROINVERTEBRATE SAMPLES. Prog. Fish-Cult. 38 (1): 30-32. Jan. 1976. SFA 21(1).

The cycle sieve provides a cost-effective, standardized means of washing benthic macroinvertebrate samples. In contrast to the common slurry technique, the sample is washed intact, mechanically. This cycle sieve consists of the bottom half of a 5-gal PVC container that is provided with screened holes and mounted on an 8-in. bicycle sprocket. The basket-sprocket assembly is fitted to a slotted pipe (34 X 1-1/4 in.) and connected by chain drive to a like sprocket at the other end of the pipe. In use, the cycle sieve is mounted to the freeboard of a boat. After the basket is loaded, the top is secured and the unit is tilted down into the water. A rotation speed of 60 cycles per minute for 3 min (1:1 gear ratio) is suitable for removing fines from mud substrates. The gear ratio, size of basket, and rotations can be modified to suit particular sieving needs and be standardized for a particular study.

76-000068 Mozley, S. C. (Great Lakes Res. Div., Univ. Mich., Ann Arbor 48109) MESH SIZE AND MACROBENTHOS IN A SHALLOW AREA OF THE GREAT LAKES. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

One objective of macrobenthic surveys near heated effluents from power plants is a description of the life cycles of abundant and important species. Changes in seasonal timing of reproduction, for instance, may disrupt benthic community structure and reduce the food available to fish in nearshore breeding grounds. In one such survey I have found that it is not possible to define seasonal cycles of Chironomidae in shallow bottoms of southeastern Lake Michigan without using a sieve mesh smaller than is used in most benthic studies in the Great Lakes. Reduction of mesh-opening width from 0.5 to 0.35 mm increased estimates of macrobenthic species by a factor of three at a station 5.6 m deep. The finer mesh retained one or two additional instars of most chironomids, added two Chironomidae and one Naididae to the species found in the sample, and increased estimates of prepupal larvae of one chironomid four-fold. In contrast use of the finer screen at a deeper (22.3 m) station did not yield major increases in abundance estimates for macrobenthic species. The benthos at the deeper station was dominated by relatively large species of amphipods, oligochaetes, and sphaeriid clams. Use of the finer screen has permitted definition of lifespan, reproductive timing, and seasonal growth of many shallow-bottom species, and some of these data will be presented in illustration. My results indicate that we should use finer mesh sizes for washing benthic samples from shallow areas of the Great Lakes.

76-000069 Murray, D. A. (Dep. Zool., Univ. Coll., Dublin 4, Ireland) A LIGHT WEIGHT CORER FOR SAMPLING SOFT SUBAQUEOUS DEPOSITS. Limnol. Oceanogr. 21 (2): 341-344. Mar. 1976. SFA 21(1).

A light weight piston corer to obtain sedimentary cores up to 2.0 m long from soft subaqueous deposits is described. This corer, which may be used in any depth of water, uses cord rubber as the driving force to propel a core tube into the sediments.

SPORT FISHERY ABSTRACTS

76-000070 O'Connor, J. F. (Dep. Nat. Resour., Saskatchewan Fish. Lab., 30 Campus Dr., Saskatoon, SK S7N 0X1, Canada) AN APPARATUS FOR SAMPLING GRAVEL SUBSTRATE IN STREAMS. Limnol. Oceanogr. 19 (6): 1007-1011. Nov. 1974. SFA 21(1).

A sampler consisting of five rods 76 cm long attached to a nonporous neoprene-coated nylon bag 63 cm long was inserted into a hole 60 cm deep dug with the aid of a culvert. Experiments with it were conducted in parallel with subsurface colonization cans and the Surber sampler. The cans contained 142.7 percent greater biomass, the Surber 72.2 percent less biomass than the bag; 28.7 percent of the fauna lived below 17.5 cm of gravel.

76-000071 Redfield, A. C. (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543) A PISTON CORER FOR PEAT. Limnol. Oceanogr. 20 (6): 1042-1045. Nov. 1975. SFA 21(1).

The construction and operation of a corer capable of recovering uncontaminated and uncompressed samples of peat and other soft sediments from precisely predetermined depths is described.

76-000072 Schwehr, D. J. (Univ. Mont., Missoula 59801) DISTRIBUTION AND DIVERSITY OF MACROINVERTEBRATES OF THE MIDDLE YELLOWSTONE RIVER. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

With a length of 670 miles and a drainage basin of 70,400 square miles, the Yellowstone River is one of the largest unimpounded rivers in the United States. Macroinvertebrates were collected from a 165 mile study section of the middle Yellowstone River to determine the distribution and taxonomic diversity of the benthic fauna.

Of the major taxonomic groups, the Ephemeroptera were the most abundant followed by Diptera, Trichoptera, and Plecoptera. Organisms of the remaining groups accounted for only 3 percent of the total fauna. Of approximately 160 benthic species that were reported from the lower 3/4 of the river, 130 species were found in the study section. Twenty-eight species of both Ephemeroptera and Trichoptera, 27 genera of the order Diptera, and 17 species of Plecoptera were collected during this study.

Taxonomic diversity of mayflies was relatively unchanged along the altitudinal gradient, although only eight species were present throughout the entire study section. Plecoptera and Trichoptera showed decreased diversity at the lower stations while Diptera were more varied at the downstream sites. Total diversity of all groups was relatively high and stable along the middle river, indicating that the ecosystem was not adversely affected by pollution or physical damage.

76-000073 Shaw, T. (Dep. Biol. Sci., Mich. Tech. Univ., Houghton 49931) AN AQUATIC INSECT SURVEY OF ELM RIVER, MICHIGAN, WITH A COMPARISON OF FOUR SAMPLING METHODS. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

An insect survey was conducted during August, of Elm River, a small brook trout tributary of Lake Superior. For data analysis, identification was to the generic level. A net/scoop/substrate method of sampling was designed to insure a thorough sample collection at each station. Rock and other large objects were removed from within an area defined by a wooden box enclosure and the attached organisms removed. A shovel/scoop apparatus was passed through the finer substrate material to collect a sample of the remaining organisms. A comparison of the net organisms to the substrate and scoop organisms is made to detect if certain taxa dislodge or actively escape more frequently than others.

SPORT FISHERY ABSTRACTS

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A series of drift net samples were collected. The drift taxa are compared to the survey taxa to detect if certain taxa drift more frequently than others.

A later series of samples were taken by three different methods. Artificial benthic environments (ABE's) were placed in the stream. After a period of 25 days, the ABE's were removed and rinsed for organisms. At the same site of each ABE, a kick sample and survey sample described above were taken. The results are compared.

76-000074 Sheldon, A. (Dep. Zool., Univ. Mont., Missoula 59801) COLONIZATION CURVES: APPLICATION TO STREAM INSECTS ON SEMI-NATURAL SUBSTRATES. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

Aquatic insects were allowed to colonize gravel-filled trays placed in a small stream. The rate of accumulation of individuals on the trays can be described by a power function or an equilibrium model. Statistical techniques for fitting these models are described. Both models fit the data but the empirical power function is more convenient to use. Colonization rates vary between taxa and depend significantly on location in the study section. It is hypothesized that the fauna of each portion of the stream bottom is influenced substantially by that of adjacent areas.

76-000075 Stoneburner, D. L.; Crossman, J. S.; Smock, L. A. (Natl. Park Serv., College Park, GA 30349) DIEL DRIFT STUDIES IN A SOUTH CAROLINA SPRING FED STREAM. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

This paper discussed a diel drift study undertaken in a small third order stream in Kings Mountain National Military Park, York County, South Carolina from April through July, 1975. Select physico-chemical water quality parameters, drift rates for live organisms and their exuviae, and standing crop were determined. Three drift samples were collected monthly at two sites, four times a day to coincide with day, dusk, and dawn photoperiods. Replicate quantitative and qualitative sampling was also done monthly at four sites.

Examination of the drift data indicated a marked diel periodicity. In April the most active period of drift was at dusk with *Simulium* and Chironomidae pupa being the most abundant organisms collected. From May through July drift was highest during the dark photoperiod. The most abundant drift organisms during these months were *Oulimnius laticulus*, *Simulium*, *Peltoperla*, *Leuctra*, *Stenomema*, *Habrophlebiodes*, *Nigronia*, and *Cheumatopsyche*. For *Oulimnius laticulus*, *Leuctra*, and *Stenomema* this may have been density related since they had the highest population densities, 178-215/m², 130-235/m², and 170-450/m², found during the study. However, drift by *Peltoperla*, *Baetis*, and Chironomidae pupa appeared to be more dependent upon ecdysis, emergence patterns, and variation in streamflow, as determined by the number of their exuviae collected.

76-000076 Thayer, G. W.; Williams, R. B.; Price, T. J.; Colby, D. R. (NMFS, Atlantic Estuarine Fish. Cent., Beaufort, NC 28516) A LARGE COBER FOR QUANTITATIVELY SAMPLING BENTHOS IN SHALLOW WATER. Limnol. Oceanogr. 20 (3): 474-480. May 1975. SFA 21(1).

A hydraulically operated device for obtaining cores 30.5 cm in diameter and up to 46 cm long is described. The corer is able to penetrate firm bottoms but is unsuited for water depths greater than 4 m. The corer was compared with a van Veen grab sampler in three substrate types in the Newport River estuary, N.C. In each case the corer yielded higher estimated of standing crops of macroinvertebrates

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than the grab sampler; it also sampled deep-dwelling invertebrates not sampled by the grab.

76-000077 Welch, H. E. (Fish. Mar. Serv., Biol. Stn., St. Andrews, NB EOG 2X0, Canada) ECOLOGY OF CHIRONOMIDAE (DIPTERA) IN A POLAR LAKE. J. Fish. Res. Board Can. 33 (2): 227-247. Feb. 1976. In English with French summ. SFA 21(1).

The six common genera of Chironomidae (Diptera) in Char Lake, Resolute, Northwest Territories (74° 42' N lat.) were studied intensively from 1969 to 1972. *Heterotrissocladius oliveri* and a *Trissocladius* species are characteristic of the sediment zone, while two species of *Orthocladius*, *Pseudodiamesa arctica*, *Paracladius quadrinodosus*, and *Lauterbornia* sp. are restricted mainly to the rocky and moss zones. Life cycles are 2 or 3 yr, depending upon the species. Year-classes could be discriminated by instar frequency distribution. Populations increased steadily during the study period, for an average increase in strength of 5 times between the 1968 and 1971 year-classes. Summer emergence and egg-laying conditions are of overriding importance to year-class strength. Mortality within year-classes is undetectable until the last 4 mo of larval life, when mortality due to char predation is about 65 percent between April and the time of emergence. The physiology of these chironomids does not seem unusual aside from continuing activity down to 0 C, and there is no indication of metabolic compensation. Net growth efficiency averages 36 percent. Assimilated energy (growth + respiration) at 8.6 kcal /m²/yr is very low compared with temperate zone populations, but is more similar as a percent of photosynthesis, 4.1 percent. The relatively large detritus pool and the presence of both 2- and 3-year species tend to stabilize chironomid energy flow. Definition of long-term averages for chironomid populations in Char Lake would require a decade or more of study.

76-000078 Williams, D. D. RECOLONIZATION MECHANISMS OF STREAM BENTHOS AS DERIVED FROM A STUDY OF SOME TEMPORARY STREAMS IN SOUTHERN ONTARIO. Ph.D. dissertation, Univ. Waterloo 1975. From Diss. Abstr. Int. B Sci. Eng. 36(5), 1975. SFA 21(1).

A detailed study of the ecology and faunal recolonization of temporary streams in Waterloo Co. Ontario, showed that the aquatic inhabitants (primarily invertebrates) belong to three main groups: permanent stream species, facultative species and specialized temporary stream species. The numbers of certain major taxonomic groups tend to over-summer as similar stages in their life cycles and the over-summering method used reflects the type of life cycle exhibited by a particular species. These variations in life cycle lead to faunal succession from the stream stage (fall-winter) through the pool stage (spring) to the terrestrial (summer). The co-existence of closely related species is common in temporary aquatic habitats and, as far as the most abundant taxa are concerned, the species composition is very stable from year to year. The faunas of temporary and permanent streams are quite dissimilar even in situations where they may be in close proximity or connected.

Four main directions are thought to contribute to the full recolonization of an area of denuded stream substrate. These are: drift, upstream migration, migration from within the substrate and oviposition. Their contribution is shown to change from drift-predominant in a permanent stream to migration from within the substrate in temporary streams. Moreover, in permanent streams, the relative importance of each changes with the season. Many groups of organisms have preferred directions from which they colonize and this may lead to the establishment of separate and distinct faunal assemblages if the other directions are excluded. Drift is shown to

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provide an effective means of dispersal within a stream and this is important in aiding the speedy recolonization of denuded areas; it contains low and high colonizers. Only about 20 percent of the animals which pass over a bare substrate settle. Experiments on site selection by aerial colonizers showed that factors such as current and food are of great importance in determining the quantitative and qualitative nature of the colonizers of streams. New water bodies are rapidly colonized by a large variety of species from nearby aquatic habitats, and it is suggested that only after some time will selection take place to favour the establishment of an appropriate lotic or lentic fauna. Observations on the natural colonization of a new stream channel served to support some of the conclusions drawn from experimentation.

PLANKTON

76-000079 Allan, J. D. (Dep. Zool., Univ. Md., College Park 20742) LIFE HISTORY PATTERNS IN ZOOPLANKTON. Am. Nat. 110 (971): 165-180. Jan.-Feb. 1976. SFA 21(1).

Freshwater zooplankton exhibit a continuum of compromises in their means of meeting the presumably conflicting demands of maximizing the potential for rapid increase, predator avoidance, and competitive ability. Rotifers and cladocerans both alternate parthenogenetic and sexual reproduction and attain high rates of increase relative to copepods. The rapidly developing small-clutch rotifers surpass more slowly developing large-clutch cladocerans in $r/(max)$. Copepods appear to consume food in a wider range of particle sizes, exhibit a greater capacity for selective feeding, and possess a greater ability in predator avoidance. Hence, ranking of three major taxa of freshwater zooplankton with respect to opportunism is: rotifers greater than cladocerans greater than copepods. These results are utilized to interpret some principal biogeographic trends in plankton composition, including the rarity or nearly complete absence of rotifers and cladocerans from the open oceans and deeper waters of large lakes. Patterns in the timing and sharpness of seasonal abundance peaks are also consistent with this interpretation, although complexities in timing occur owing to intrataxon variation in keying to seasonal fluctuations. (Auth Summ.)

76-000080 de Bernardi, R.; Canali, S. (Ist. Ital. Idrobiol., 28048 Pallanza, Italy) POPULATION DYNAMICS OF PELAGIC CLADOCERANS IN LAGO MAGGIORE. Mem. Ist. Ital. Idrobiol. 32: 365-392. 1975. In English with Italian summ. SFA 21(1).

The population dynamics of six pelagic species of cladocerans of Lago Maggiore is analyzed. Their trophic relations and interactions are studied. The temporal modification in the structure of the whole community is analyzed and discussed.

76-000081 Environmental Protection Agency (Natl. Environ. Res. Cent., 200 SW 35th St., Corvallis, OR 97330) PROCEEDINGS: BIOSTIMULATION/AND/NUTRIENT ASSESSMENT WORKSHOP. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-034. iv + 319p. June 1975. SFA 21(1).

The workshop was held to bring together those investigators in the Environmental Protection Agency who are actively engaged in research relating to biostimulation and nutrient assessment to present the results of their studies. The papers presented were concerned with the results of algal assays conducted on various waters and wastes to

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determine their biostimulatory effects as well as the results of other research relating to the assessment of nutrients and their effects on the aquatic ecosystem.

76-000082 Furnass, T. I.; Findley, W. C. (Freshwater Biol. Assoc., Windermere Lab., The Ferry House, Ambleside, Columbia LA22 OLP, England) AN IMPROVED SORTING DEVICE FOR ZOOPLANKTON. *Limnol. Oceanogr.* 20 (2): 295-297. Mar. 1975. SFA 21(1).

An improved version of Nivalis' device is described together with an alternative method which can be used for sorting live planktonic crustaceans with little stress and for handling particularly agile animals with ease. With this new design and method it is impossible for individual animals to return to the viewing chamber after sorting, and the number of groups of organisms that can be separated from a mixed culture at one time has been raised to three.

76-000083 Garrison, D. L. (Coastal Mar. Lab., Univ. Calif., Santa Cruz 95064) CONTRIBUTION OF THE NET PLANKTON AND NANNOPLANKTON TO THE STANDING STOCKS AND PRIMARY PRODUCTIVITY IN MONTEREY BAY, CALIFORNIA DURING THE UPWELLING SEASON. *NOAA Fish. Bull.* 74 (1): 183-194. Jan. 1976. SFA 21(1).

Net plankton and nanoplankton standing stocks and primary production were measured in Monterey Bay, Calif. from January through August 1972. Throughout the period of seasonal upwelling, the phytoplankton stocks were dominated by net plankton. Both fractions showed seasonal changes; the net plankton concentrations increased dramatically during upwelling, while nanoplankton concentrations were decreased. Nanoplankton growth rates exceeded net plankton rates at incubator light levels; however, at higher in situ light levels near the surface, this relationship appeared to be reversed.

Nanoplankton decreases may have been related to their selective removal from the area of upwelling by horizontal advection or selective grazing on the nanoplankton fraction. Net plankton dominance during upwelling has been related to their higher growth rates when populations are retained in shallow nutrient-rich nearshore waters.

76-000084 Helzer, G. R. POPULATION DYNAMICS AND PRODUCTION OF LIMNETIC CRUSTACEAN ZOOPLANKTON IN FIVE SOUTHEASTERN NEBRASKA FLOOD CONTROL RESERVOIRS. Ph.D. dissertation, Univ. Nebr. 211p. 1974. *From. Diss. Abstr. Int. B Sci. Eng.* 35(8), 1975. SFA 21(1).

Populations of limnetic crustacean zooplankton (cladocera, copepoda) were studied in five flood control reservoirs in Southeastern Nebraska during the period, May, 1968 to December, 1973. The summer limnetic crustacean zooplankton community consisted of, on the average, 3.07 cladoceran species and 2.26 copepod species, for an average momentary community composition of 5.33 species. Birth rates, population change rates and mortality rates were computed for dominant and, in some cases, sub-dominant cladocerans. Relationship of population statistics of cladocerans to phytoplankton food supply and to predation by planktivorous fishes is discussed. Secondary production was computed for the most important cladocerans in Pawnee, Branched Oak, Stagecoach and Wagontrain reservoirs. Production rate of the dominant species exceeded that of the sub-dominant by 4-5 times in summer and by about 20 times in winter. Relationship of the zooplankton to eutrophication is discussed. Size-selective predation by planktivorous fishes with increasing eutrophication has caused replacement of several species of zooplankters by smaller-bodied species. Total cladoceran production was estimated for each reservoir. Trophic state of each reservoir is assessed, based on comparison of secondary production data with values

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found in the literature. Standing crop estimates (number/l) do not necessarily reflect estimates of zooplankton production.

76-000085 LaRow, E. J. (Dep. Biol., Siena Coll., Loudonville, NY 12211) SECONDARY PRODUCTIVITY OF /LEPTODORA KINDTII/ IN LAKE GEORGE, N.Y. Am. Midl. Nat. 94 (1): 120-126. July 1975. SFA 21(1).

Biomass and turnover rates were used to estimate secondary production of /Leptodora kindtii/ in Lake George, N.Y., during 1970 and 1971. Maximum values for production during both years were measured in mid-July. The average annual production was 55 percent greater in 1970 than in 1971. In 1970, there was a S-N gradient in productivity with the southern basin being 1.5 times as productive as the northern basin. However, the opposite was true in 1971 when there was an increase in production along the S-N gradient. Variation between the data sets was most likely due to localized annual variation in prey and/or predator densities. It was concluded that although there may be localized seasonal or annual variations, /Leptodora/ production did not exhibit a gradient of production within Lake George as had been reported for lower trophic levels.

76-000086 Lorenz, B. D. (Dep. Biol., W. Va. Univ., Morgantown 26506) NUTRIENT CONCENTRATIONS AND THE NET PLANKTON COMMUNITY OF SUMMERSVILLE LAKE, A MAINSTREAM IMPOUNDMENT. M.S. thesis, W. Va. Univ., Morgantown ix + 143p. 1975. SFA 21(1).

Summersville Lake was sampled at approximately two week intervals from September 25, 1971, to October 7, 1972. No samples were taken from December 4, 1971, to March 25, 1972, due to the inaccessible nature of the reservoir.

Stratification was established by May 13 and continued through September 2. Disruption of stratification was evident on June 24 following intense rain and flooding accompanying Hurricane Agnes. Concentrations of nitrate and orthophosphate remained well above detectable limits with nitrate having an epilimnic mean of 2.4 mg/l during the stratified period and the mean epilimnic orthophosphate concentration being 7.9 ug/l. Concentrations of total inorganic iron and total phosphate showed a positive correlation with depth. Sulfate concentrations were similar throughout the water column. Although trace amounts of ammonia and hydrogen sulfide were found, the hypolimnic withdrawal employed in the reservoir and a moderate E.O.L. at all depths sampled make it seem unlikely that accumulations are common. The net zooplankton were predominantly cyclopoid copepods and cladocerans. The most abundant of these were the copepods /Mesocyclops edax/ and /Cyclops bicuspidatus thomasi/ and the cladocerans /Daphnia ambigua/ and /Bosmina longirostris/. A single calanoid copepod, /Diaptomus pallidus/, was encountered in the study. A seasonal alternation of /M. edax/ and /C. b. thomasi/ was apparent and seasonal succession of /D. ambigua/ with three additional species of /Daphnia/ was evident. The net phytoplankton included only a single blue-green species, /Chroococcus limneticus/.

On the basis of nutrient concentrations and the net plankton community, Summersville Lake may be considered mesotrophic. Although nutrient levels appear to be sufficient to promote eutrophication, the rapid rate of water exchange retards the process. (BS)

76-000087 Makarewicz, J. C. THE COMMUNITY OF ZOOPLANKTON AND ITS PRODUCTION IN MIRROR LAKE. Ph.D. dissertation, Cornell Univ. 221p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(11), 1975. SFA 21(1).

An intensive study of the zooplankton community of Mirror Lake, New Hampshire, was undertaken from October, 1968 through September, 1971. The seasonal and vertical distribution, biomass, production, and respiration of eighteen species were investigated. The major goals of this study were to estimate and further develop methods of measuring zooplankton production and respiration, to evaluate the importance of Rotatoria in the transfer of energy in lake ecosystems, and to investigate the division of niche and habitat space by zooplankton. (From Auth. Abstr.)

76-000088 McNaught, D. C.; Buzzard, M.; Levine, S. (Dep. Biol. Sci., State Univ. N.Y., Albany 12222) ZOOPLANKTON PRODUCTION IN LAKE ONTARIO AS INFLUENCED BY ENVIRONMENTAL PERTURBATIONS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-021. viii + 156p. June 1975. SFA 21(1).

The Crustacean zooplankton are excellent indicators of environmental perturbation, especially as enough of their biology is known to explain why certain species increase with nutrient enrichment of lakes. The distribution of zooplankton in Lake Ontario suggested that eutrophic indicators were found in the vicinity of major urban centers. The ratio of the number of *Bosmina longirostris*, the most successful eutrophic species, to *Diaptomus sicilis*, the most oligotrophic form, supported this conclusion. Furthermore, mathematical indices, including diversity, the community competition coefficient, and carrying capacity, separated urban inshore from rural inshore waters, further evidence of perturbation. Biomass estimates made with new acoustical techniques indicated that most of the zooplankton biomass was in deep waters, thus the eutrophication of Ontario's waters, both nearshore and in the vicinity of cities, is still localized in nature. Mathematical techniques have been developed to model such perturbations.

76-000089 Munawar, M.; Munawar, I. F. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) A LAKEWIDE STUDY OF PHYTOPLANKTON BIOMASS AND ITS SPECIES COMPOSITION IN LAKE ERIE, APRIL-DECEMBER 1970. J. Fish. Res. Board Can. 33 (3): 581-600. Mar. 1976. In English with French sum. SFA 21(1).

Surface samples of phytoplankton were collected from April to December 1970 at approximately 4-wk intervals from 25 stations distributed over the entire lake. Taxonomic identification and enumeration was done by the Utermohl technique. About 125-150 species were identified in each basin. "Less common" or rare species contributed significantly to the total phytoplankton biomass. The species comparison among the three basins indicated that species like *Rhodomonas minuta* and *Cryptomonas erosa* were perennial in all the basins. *Aphanizomenon flos-aquae*, *Anabaena spiroides* var. *contracta*, *Coscinodiscus rothii*, *Actinastrum hantzschii*, and *Ceratium hirundinella* were typical for the Western basin. *Ochromonas* spp. and *Peridinium aciculiferum* were common in the Central basin whereas *Gymnodinium helveticum* and *G. uberrimum* were characteristic for the Eastern basin.

The diatoms contributed least in the Eastern basin (36 percent) but showed high percentage in both Central (55 percent) and Western (58 percent) basins. The phytoflagellates made important contributions in the three basins; highest percentage (41 percent) was in the Eastern basin. Phytoflagellate abundance increased from west to east and appeared to have a wide range of adaptability to different nutrient conditions. During July and August high biomass concentration but

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uneven horizontal distribution was observed. Phytoplankton biomass ranged between 0.8 and 13.2, 0.6 and 6.0, and 1.0 and 4.2 g/m³ in the Western, Central, and Eastern basins, respectively. The highest biomass of 13.2 g/m³ was in the Western Basin during April. Inshore-offshore differentiation was observed in the Central and Eastern basins with many peaks in the inshore region. Size analysis of phytoplankton on a few stations showed that the nanoplankton ($\leq 64 \mu$) comprised a major portion of phytoplankton biomass during spring and fall periods. Based on maximum biomass concentration the Lake Erie Western basin was classified as highly eutrophic, the Eastern basin as mesotrophic, and the Central basin between the mesotrophic and eutrophic conditions.

76-000090 Pearcy, W. G. (Sch. Oceanogr., Oreg. St. Univ., Corvallis 97331) SEASONAL AND INSHORE-OFFSHORE VARIATIONS IN THE STANDING STOCKS OF MICRONEKTON AND MACROZOOPLANKTON OFF OREGON. NOAA Fish. Bull. 74 (1): 70-80. Jan. 1976. SFA 21(1).

Dry weights of pelagic animals captured along an inshore-offshore station line with Isaacs-Kidd mid-water trawls and 1-m diameter plankton nets during a 5-yr period provided evidence for seasonal changes in the standing stocks of carnivores. Micronekton catches (fishes, shrimps, and squids) were largest inshore (28 and 46 km offshore) in the winter (November-April), and offshore (84 and 120 km) during the summer (May-October), the season of coastal upwelling. No seasonal difference was detected in the biomass of herbivores, or in its primary components, the copepods and euphausiids. Increased biomass of medusae during the summer resulted in significant seasonal differences in the planktonic carnivores at the inshore stations.

The average biomass (grams per square meter) of small nektonic and planktonic carnivores, averaged over the year, peaked at the 84-km station. The biomass of fishes was greater than shrimps and the biomass of shrimps was greater than that of squids at all stations, except 46 km where shrimps predominated. Herbivore biomass was maximal at 46 km, over the inner continental slope, largely because of the high catches of euphausiids at this station. The occurrence of largest average catches at intermediate distances from shore, and inshore-offshore shifts in peak biomass with seasons, may result from seasonal changes in upwelling and downwelling and exclusion of vertical migrants from shoal waters on the shelf.

Herbivore:carnivore biomass ratios differed significantly between inshore and offshore stations. Standing stocks of herbivores were several times larger than those of carnivores in nearshore waters, but the ratio was about 1.0 in offshore waters. Coefficients of variation (s/mean x) of herbivore and planktonic carnivore stocks for the entire sampling period were highest inshore, indicating high variability, and decreased markedly in offshore waters. These trends suggest that, compared to offshore or oceanic communities, the pelagic inshore-upwelling ecosystem may be less predictable and have a lower ecological efficiency.

76-000091 Pederson, G. L. PLANKTON SECONDARY PRODUCTION AND BIOMASS: SEASONALITY AND RELATION TO TROPHIC STATE IN THREE LAKES. Ph.D. dissertation, Univ. Wash. 119p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(8), 1975. SFA 21(1).

The population cycles, abundance, biomass and production of the most important species of zooplankton were followed during 1972 and 1973 for three lakes of varying trophic status in the Lake Washington watershed. Trophic states of lakes Findley and Chester Morse are considered to be oligotrophic; while most characteristics indicate Lake Sammamish to be mesotrophic.

Chester Morse and Findley Lakes had low average numerical abundance

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and biomass values, while values for Lake Sammamish were considerably higher. Copepods were the most abundant component of the zooplankton in lakes Sammamish and Chester Morse. Rotifers and cladocerans were of approximately equal abundance in Chester Morse Lake. Copepods dominated the biomass in Lake Sammamish. Cladocerans and copepods were of equal importance in the biomass of lakes Findley and Chester Morse. Rotifers were unimportant components of the biomass in all lakes.

The lowest secondary production values (both on an annual and daily basis) were observed in Chester Morse Lake, while the highest values were found in Lake Sammamish. Findley Lake results showed extreme fluctuations: 1972 values were near those for Chester Morse Lake, while 1973 values were in the range of those for Lake Sammamish. A surprising result of this study was the magnitude of cladoceran production in the three lakes. Cladocerans dominated production in lakes Sammamish and Chester Morse, while in Findley Lake their role was about equal to that of the copepods. Within the lakes of the Lake Washington watershed, secondary production was better correlated with chl a than with primary production ($r = 0.702$ and 0.461 respectively).

Data from this study supported Hillbricht-Ilkowska's postulate that the energy transfer efficiency between the primary and secondary trophic levels decreases with increasing trophic state. Energy transfer efficiencies for the lakes of this study expressed as a two year mean of the ratio: secondary: primary production, were as follows: Findley Lake--0.13; Chester Morse Lake--0.08; and Lake Sammamish--0.04.

On the other hand, the hypothesis of Patalas that the secondary productivity: biomass ratio (P/B) tended to increase in proportion to the productivity of a lake, could not be supported. Lake Sammamish, the most productive (mesotrophic) of the lakes studied, had a P/B ratio of 0.03 while lakes Findley and Chester Morse (both oligotrophic) had P/B ratios of 0.04.

76-000092 Pommel, E. (Secr. d'Etat Environ., 14, bd du General Leclerc, 92521, Neuilly-sur-Seine, France) DISTRIBUTION ET SIGNIFICATION ECOLOGIQUE DE LA VITAMINE B(12) ET DE LA THIAMINE DANS TROIS LACS SUBALPINS ET JURASSIEN. [DISTRIBUTION AND ECOLOGICAL SIGNIFICANCE OF VITAMIN B(12) AND THIAMIN IN THREE LAKES.] Ann. Hydrobiol. 6 (2): 103-121. 1975. In French with English summ. SFA 21(1).

Many phytoplanktonic species must find some vitamin in their environment if they are to grow. Monthly tests of vitamin B(12) and thiamin were undertaken in Nantua, Leman and Annecy lakes in order to ascertain the ecological significance of these compounds. Test organisms were *Englena gracilis* for vitamin B(12) and *Lactobacillus fermenti* for thiamin tests.

In Nantua and Leman lakes, a decrease in contents of vitamin B(12) and macronutrients in the superficial waters was observed together with the springtime algal growth. For example vertical distribution of vitamin B(12) in Nantua lake during spring is the same as dissolved inorganic phosphorus distribution and inverse to *Oscillatoria rubescens* distribution.

However, in summer, great growths of *Oscillatoria redekei* and *Aphanizomenon flos aquae* increase the vitamin content of epilimnion. *Oscillatoria redekei* and *Aphanizomenon flos aquae* may produce vitamin B(12) while *Oscillatoria rubescens* may consume it, at least in spring. (Auth. Summ.)

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76-000093 Rao, S. S.; Burnison, B. K. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) BACTERIAL DISTRIBUTIONS IN LAKE ERIE (1967-1970). J. Fish. Res. Board Can. 33 (3): 574-580. Mar. 1976. In English with French summ. SFA 21(1).

Distribution of heterotrophic and coliform bacteria in Lake Erie is a first step in determining the importance of bacteria in the lake. The abundance of these organisms was greatest in the Western basin. Offshore bacterial densities from the Central and Eastern basins were lower than the inshore areas. Detroit River, Grand River (Ontario), and the areas close to Erie, Pennsylvania and Cleveland, Ohio showed the highest bacterial densities throughout the study periods.

76-000094 Walsh, J. J. (Div. Oceanogr. Sci., Eerohaven Natl. Lab., Upton, NY 11973) HERBIVORY AS A FACTOR IN PATTERNS OF NUTRIENT UTILIZATION IN THE SEA. Limnol. Oceanogr. 21 (1): 1-13. Jan. 1976. SFA 21(1).

A comparison of the horizontal nutrient gradients in coastal upwelling systems of the eastern boundary currents, in offshore divergences of high and low latitudes, and in the central gyres of the oceans suggests that changes in the dominant frequencies of variability of the physical habitat may define the importance of grazing stress as a constraint to nutrient utilization in the sea.

76-000095 Watson, N. H. F. (Canada Cent. Inland Waters Burlington, ON L7R 4A6, Canada) SEASONAL DISTRIBUTION AND ABUNDANCE OF CRUSTACEAN ZOOPLANKTON IN LAKE ERIE, 1970. J. Fish. Res. Board Can. 33 (3): 612-621. Mar. 1976. In English with French summ. SFA 21(1).

The lakewide horizontal distribution and seasonal abundance of the cyclopoids, cladocerans, and calanoids in Lake Erie from April to December 1970, are presented.

Over much of the year cyclopoids dominated by *Diacyclops bicuspidatus thomasi* were most numerous with offshore centers of abundance. Several species of cladocerans, often with short peaks of occurrence, were most abundant during summer in the Western basin and associated with south shore population centers in the Central basin. Calanoids were frequently much less abundant than either of the two groups but present in the same areas as the cladocerans.

Most species present were short-lived with a high reproductive potential. Environmental clues are postulated to control specific abundance making group numbers more constant. Several life-cycle patterns were evident including species with spring-fall maxima and those with a single peak.

Timing of peak abundance of certain species and groups varies from west to east in the same fashion as temperature differences giving rise to east-west gradients of abundance which change with season. Cladoceran and calanoid groups show similarities in distribution pattern with estimates of particulate organic material rather than with algal abundance resulting in north-south gradients of abundance.

PRIMARY PRODUCTION

76-000096 Gasith, A.; Hasler, A. D. (Univ. Wis., WARF Bldg., 610 N. Walnut St., Madison 53706) AIRBORNE LITTERFALL AS A SOURCE OF ORGANIC MATTER IN LAKES. Limnol. Oceanogr. 21 (2): 253-258. Mar. 1976. SFA 21(1).

An evaluation of the importance of airborne litterfall as a source of organic matter in lakes is suggested, based on the input of the airborne litterfall relative to the contribution from autochthonous

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primary production and the ratio of the shoreline to the lake area. The results suggest that airborne litterfall could be important (at least 10 percent of phytoplankton production) in oligotrophic and very small eutrophic lakes. This evaluation may be useful in studies of organic matter budgets of aquatic systems to indicate whether airborne litterfall may be potentially important as a source of carbon and should be directly measured.

76-000097 Gerhart, D. Z.; Likens, G. E. (Dep. Biol., Univ. Minn., Duluth 55812) ENRICHMENT EXPERIMENTS FOR DETERMINING NUTRIENT LIMITATION: FOUR METHODS COMPARED. *Limnol. Oceanogr.* 20 (4): 649-653. July 1975. SFA 21(1).

Four nutrient bioassay techniques were compared in studies of an oligotrophic, soft-water lake in New Hampshire. Enrichments of large polyethylene enclosures, continuous cultures of the natural phytoplankton community, and long term ^{14}C bioassays agree in demonstrating that nitrogen and phosphorus limit phytoplankton growth in this lake. However, in short term (4-30 h) ^{14}C bioassays, nitrogen and phosphorus enrichments did not stimulate phytoplankton production. Care should be exercised in extrapolating results from short term, bottle bioassays to measures for controlling eutrophication.

76-000098 Jones, J. R. EUTROPHICATION OF SOME NORTHWESTERN IOWA LAKES. Ph.D. dissertation, Iowa State Univ. 92p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(8), 1975. SFA 21(1).

A water quality study of the Iowa Great Lakes and their tributaries was conducted from March 1971 to August 1973 to determine the limnological condition of each lake and the reasons for differences in the degree of eutrophication among the lakes. Each of the Iowa Great Lakes is eutrophic with summer algal problems. The lakes ranked in order of increasing eutrophy using plant nutrient and chlorophyll *a*/concentrations, chemical oxygen demand, and Secchi disk transparency are: Lake West Okoboji, Spirit Lake, Lake East Okoboji (including Upper Gar Lake and Lake Minniwashta) and Lower Gar Lake. The mean depth decreases, and the ratio of watershed area to lake volume increases with increasing lake eutrophy.

These lakes likely have been eutrophic for several thousand years. A decrease in the molluscan fauna of Lake West Okoboji and the replacement of aquatic macrophytes in Lake East Okoboji by blue-green algae since the beginning of this century could be signs of increased recent eutrophication. An increase in hypolimnetic oxygen deficit in Lake West Okoboji in the past 50 years indicates algal production has increased.

Measurements were made of the amounts of phosphorus and nitrogen carried into the lakes by tributary streams and rainfall. Nutrient budgets were determined for each lake. A land-use inventory was made of the watersheds of each tributary stream sampled. This included the percentages of the watersheds that were used for row crops, pastures, marshes, woodlands, and urban uses as well as the numbers of animal units. A multiple regression analysis was used to determine which land uses were associated with variations in the amounts of phosphorus and nitrogen carried in the stream waters. Animal units held in feedlots with drainage to a stream or tile were significantly correlated with phosphorus and ammonia nitrogen losses from the watersheds. It was estimated this source accounted for 15 percent of the total phosphorus input to these lakes.

The hypothesis that the annual input of plant nutrients is a major factor in determining the summer standing crop of plankton algae was tested on the Iowa Great Lakes. The nutrient inputs were normalized by taking the total amounts of phosphorus and inorganic nitrogen entering the lakes in 1971, 1972, and 1973, divided by the lake volumes to

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yield potential concentrations. A highly significant relationship was found when the mean July-August chlorophyll /a/ values from each lake were regressed on the potential phosphorus concentrations. The year of greatest phosphorus input was the year of highest algal biomass. This relationship was extended to other lakes over a wide trophic range using published data. I concluded that a nutrient abatement program would have to reduce potential phosphorus inputs to 0.02 mg/l before water clarity would improve.

76-000099 Munawar, M.; Burns, N. M. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) RELATIONSHIPS OF PHYTOPLANKTON BIOMASS WITH SOLUBLE NUTRIENTS, PRIMARY PRODUCTION, AND CHLOROPHYLL /a/ IN LAKE ERIE, 1970. J. Fish. Res. Board Can. 33 (3): 601-611. Mar. 1976. In English with French summ. SFA 21(1).

Comparison of the annual average distribution patterns of phytoplankton biomass, chlorophyll /a/, primary production, soluble reactive phosphorus, nitrate + nitrite, and ammonia concentrations revealed that these six variables had very similar distributions in Lake Erie during 1970. However, statistical analysis of the data only revealed a few consistent relationships between these variables. The phytoplankton biomass was correlated with chlorophyll /a/ only in the summer and fall as was primary production with chlorophyll /a/ and biomass. There was no correlation between these three variables during the spring. Also, there was no consistent relationship between biomass and soluble nutrients. The primary production and activity coefficient (mg C (assimilated) per milligram phytoplankton biomass per day) were found to be unrelated to temperature. The statistical procedure of factor analysis showed that in the spring, primary production correlated with the phosphorus and nitrogen soluble nutrients only, whereas during summer, primary production correlated with biomass, chlorophyll /a/, the major plankton groups (Cyanophyta, Chlorophyta, Chrysomonadinae, and Diatomeae), and the phosphorus nutrients. In the fall, production was positively correlated with phytoplankton biomass and with the Chlorophyta in particular. The use of chlorophyll /a/ and temperature as variables in the equation to estimate phytoplankton growth in Lake Erie was found to be questionable.

76-000100 Naiman, R. J. (Dep. Fish. Wildl., Oreg. State Univ., Corvallis 97331) PRIMARY PRODUCTION, STANDING STOCK, AND EXPORT OF ORGANIC MATTER IN A MOHAVE DESERT THERMAL STREAM. Limnol. Oceanogr. 21 (1): 60-73. Jan. 1976. SFA 21(1).

The water of a thermal artesian stream (Tecopa Fore) in the Mohave Desert near Death Valley, California, issues from the ground at 47.5 C and cools 8-12 C before leaving a study area 300 m long. Growth occurs year round because of the high water temperature. Pupfish are the dominant herbivores; aquatic invertebrates are rare.

The 11,065 kcal/m² annual input of energy to the biological system is totally accounted for by autochthonous primary production. About 718 kcal/m² of organic matter is stored within the system in the form of algal mats and detritus and has a turnover time of about 23 days. The bulk of the annual primary production (81 percent) is channeled into respiration and decomposers; 9 percent is lost as dissolved organic carbon and 4 percent as drift of particulate organic matter. Pupfish (*Cyprinodon nevadensis amargosae*) feed on algae and detritus, ingesting 17 percent (1,878 kcal/m²/yr) of the annual primary production, of which 119 kcal/m²/yr is deposited in growth.

76-000101 Nalewajko, C.; Schindler, D. W. (Scarborough Coll., Univ. Toronto, West Hill, ON M1C 1A4, Canada) PRIMARY PRODUCTION, EXTRACELLULAR RELEASE, AND HETEROTROPHY IN TWO LAKES IN THE ELA, NORTHWESTERN ONTARIO. J. Fish. Res. Board Can. 33 (2): 219-226. Feb. 1976. In English with French summ. SFA 21(1).

During short-term experiments with phytoplankton, excretion rates of ^{14}C labeled organic substances may change without concomitant changes in photosynthetic rates. Percentage extracellular release (p.e.r.) values generally decreased with time.

In eutrophic Lake 227, p.e.r. after 3-h incubation ranged from about 1 to 4 percent, depending on light intensity, when phytoplankton biomass was high, but the range was from about 7 to 15 percent at a time of low biomass. In oligotrophic Lake 239 p.e.r. was about 20 percent. Mainly large molecules, exceeding 1500 mol wt, were excreted by phytoplankton. A tracer bioassay gave significantly lower estimates of acetate and glucose concentrations than the Michaelis-Menten analysis. Extracellular release rates of dissolved organic compounds by phytoplankton exceeded the total heterotrophic uptake rates of acetate, glucose, and glycylate.

76-000102 Schindler, D. W.; Fee, E. J. (Fish. Mar. Serv., Freshwater Inst., Winnipeg, MB, Canada) PRIMARY PRODUCTION IN FRESHWATER. Presented at the First International Congress of Ecology, The Hague, The Netherlands, 8-14 Sept. 1974. 4p. 1974. Available as Reprint No. 351 from the Freshwater Inst. Winnipeg, Manitoba, Canada. SFA 21(1).

Annual phytoplankton production was correlated with annual phosphorus income for 47 sites where both measurements were made. Annual nitrogen income, nutrient concentration, and chlorophyll were poorly correlated with phytoplankton production.

The correlation between latitude and phytoplankton production observed by Brylinski (1974) appears to be due only in part to the influence of solar radiation. Latitudinal differences in nutrient input from precipitation, runoff and cultural sources appear to be other factors responsible for the observed correlation. (Auth. Summ.)

76-000103 Stephens, L. W.; Gillespie, D. M. (Dep. Bic., Univ. Utah, Salt Lake City 84112) PHYTOPLANKTON PRODUCTION IN THE GREAT SALT LAKE, UTAH, AND A LABORATORY STUDY OF ALGAL RESPONSE TO ENRICHMENT. Limnol. Oceanogr. 21 (1): 74-87. Jan. 1976. SFA 21(1).

The annual production by phytoplankton in the southern basin of the Great Salt Lake as estimated at two stations in 1973 averaged 145 g C/m². The majority of the production occurred during March and April and was due to an unidentified species of *Dunaliella*. Daily carbon fixation rates averaged 2.13 g C/m² at both locations during this period. A minor phytoplankton bloom in August, due to a small, unidentified green flagellate contributed 5 percent of the total annual phytoplankton production. Phytoplankton production was probably limited during April by self-shading and during the remainder of the year by the availability of nitrogen, as shown by laboratory bioassays. Grazing by *Artemia salina* reduces the phytoplankton population in late summer when nutrient levels have partially increased due to regeneration. The merocyclic character of the lake was indicated by profiles of temperature and density. The monimolimnion is postulated to act as a nutrient sink, reducing the rate of nutrient release to the mixolimnion.

76-000104 Taylor, M. K.; Marzolf, G. R. (Div. Biol., Kans, State Univ., Manhattan 66506) ESTIMATION OF BENTHIC, PLANKTONIC, AND TOTAL PHOTOSYNTHETIC PRODUCTION IN THE KANSAS RIVER. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

The Kansas River is a turbid, 5th or 6th order stream with a predominantly sandy substrate. The channel is shallow (braided at low flow). The instability of the sand substrate provides a highly dynamic environment for the establishment and growth of benthic algae; at times the photosynthesis of organic matter in the river occurs on the substrate and at times the cells break free and the synthesis takes place as they are drifting free in the current of the river. Both benthic and planktonic production rates can be substantial reflecting high nutrient levels in the river, yet under high flow rates the production is reduced.

Following a period of high turbid flow, total and planktonic production were estimated over a month long period, including 240 consecutive hours. Flow, nutrients, light, turbidity, temperature, oxygen and substrate character were monitored. Benthic production was estimated by difference from total production and planktonic production estimates.

Planktonic production was substantial. Ratios of planktonic to benthic production were observed to vary as the producer communities developed thru time.

MORPHOLOGY

76-000105 Ahlbert, I.-B. (Dep. Zool., Univ. Stockholm, Sweden) ORGANIZATION OF THE CONE CELLS IN THE RETINAE OF SALMON (*SALMO SALAR*) AND TROUT (*SALMO TRUTTA TRUTTA*) IN RELATION TO THEIR FEEDING HABITS. Acta Zool. (Stockh.) 57 (1): 13-35. 1976. SFA 21(1).

Regional variations of cone density, cone types and cone mosaic were investigated by light microscopy in yolk sac fry, parr and adults of salmon (*Salmo salar*) and trout (*Salmo trutta trutta*) and related to the feeding habits of different stages. The retinal organization of the two species is similar, as are their feeding habits. In parr and adult of both species a region with high cone density was found in the ventro-temporal part of the retina. The lowest values of cone density were found centrally in the dorsal half of the retina. An increase in cone density towards the *cra serrata* was noted in all retinæ investigated. There is a good agreement between the density distribution of the cones in parr of salmon and trout and their feeding habits. The parr feed to a great extent on the invertebrate drift. Facing the current, the parr search the water region in front and above themselves for food organisms, thereby probably making use of the ventro-temporal area of high cone density. The connection between the cone density distribution and the feeding habits is less clear in adult salmon and trout, but the high cone density region is probably used when they feed on surface organisms and schooling prey. The ecological significance of cone types and cone mosaics is discussed.

During growth there was a change of the cone mosaic from a regular square pattern in the fry towards a less regular square or row pattern in the adults. The position of regions with high and low cone density did not change during development in each species and had a similar distribution in the two species. On the other hand, the range of cone density values becomes relatively greater as the animal grows older. The cone density distribution seems to be more homogeneous in parr than in adults. Differences in the relative density distribution of the cones are influenced by recruitment at the retinal periphery and

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by spreading out of existing cells. In addition to the /ora serrata/, mitoses were also observed in more central parts of the retina having well-differentiated receptors and a cone mosaic. Mitoses were noted in all three nuclear layers but were most frequent in the outer nuclear layer, in which the resulting cells probably differentiate into rods. Undifferentiated zones similar to the peripheral growth zone of the retina were found on both sides of the falciform process in fry. In parr and adults an undifferentiated zone persisted only on the temporal side. It probably contributes to the high cone density in the ventro-temporal part of the retina by a delivery of new cells.

76-000106 Behnke, R. J.; Kloppel, T. M. (Dep. Zool., Colo. State Univ., Ft. Collins 80523) AN EXPRESSION OF UNEQUAL TWINNING IN AN ADULT RAINEOW TROUT. *Copeia* 1975 (4): 775-777. 31 Dec. 1975. SFA 21(1).

76-000107 Denoncourt, R. F. (York Coll. Pa., Country Club Rd., York 17405) SEXUAL DIMORPHISM AND GEOGRAPHIC VARIATION IN THE BRONZE DARTER, /PERCINA PALMARIS/ (PISCES: PERCIDAE). *Copeia* 1976 (1): 54-59. 12 Mar. 1976. SFA 21(1).

The study indicates that males of /Percina palmaris/ have significantly higher fin counts and longer depressed second dorsal and anal fins than females. This sexual dimorphism is more significant on specimens from the Tallapoosa than the Coosa River drainage. Females from the Tallapoosa are 94.4 percent separable from 88 percent of the males on the basis of anal soft ray count, while the average divergence in dorsal soft rays and anal soft rays for both drainages ranges from 72.8 to 73.5 percent.

Tubercles and tubercular ridges are described from male specimens.

76-000108 Fine, M. L. (Grad. Sch. Oceanogr., Univ. R.I., Kingston 02881) SEXUAL DIMORPHISM OF THE GROWTH RATE OF THE SWIMBLADDER OF THE TOADFISH /OPSANUS TAU/. *Copeia* 1975 (3): 483-490. 5 Aug. 1975. SFA 21(1).

The swimbladders with the attached drumming muscles of 144 toadfish were measured for width and weight. These values, when regressed against the total lengths and weights of the fishes, demonstrated that after an initial period of equal growth rate, the swimbladders of males grew faster than those of females. Bladders of females typically grew to 3 to 4 gm, while those of males were commonly over 8 gm. Bladder-weight bladder-width regressions of males and females were not significantly different, pointing to a morphological similarity of the bladders. Therefore sexual differences in the sound production of this species (males and females make different calls) suggest neural and hormonal differences rather than differences in the structure of the sound-producing organ.

Literature on sexually dimorphic swimbladders as sound-producing organs was reviewed, and it was concluded that the toadfish's dimorphism is unlike any yet described.

76-000109 Landolt, J. C.; Hill, L. G. (Div. Sci. Math., Shepherd Coll., Shepherdstown, WV 25443) OBSERVATIONS OF THE GROSS STRUCTURE AND DIMENSIONS OF THE GILLS OF THREE SPECIES OF GARS (LEPISOSTEIDAE). *Copeia* 1975 (3): 470-475. 5 Aug. 1975. SFA 21(1).

Gars are considered to be facultative air breathers under routine environmental conditions. However, at low ambient oxygen concentrations and/or high ambient temperatures, they may become obligatory air breathers, gulping air at the surface into their highly vascularized swim bladder. Gill surface areas of fishes with accessory

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aerial breathing capacity are frequently described as "reduced" compared to species that are strictly gill breathers. Examination of gill structure and measurements of gill surface areas of three species of gars indicate that these fishes are very similar to teleost species in gill anatomy and organization; that the gill surface areas of gars are reduced compared to many teleost species, but do not show the apparent extreme reduction or structural modification reported in the dipnoian lungfishes and certain other air breathing forms. During growth gars exhibit differential gill development patterns similar to those described for several teleost species producing a progressive reduction in the ratio of gill surface area to body weight with increase in size.

76-000110 Liem, K. F.; Osse, J. W. M. (Mus. Comp. Zool., Harvard Univ., Cambridge, MA 02138) BIOLOGICAL VERSATILITY, EVOLUTION, AND FOOD RESOURCE EXPLOITATION IN AFRICAN CICHLID FISHES. *Am. Zool.* 15 (2): 427-454. 1975. SFA 21(1).

Increased potential versatility in form and function of the feeding apparatus of cichlid fishes has led to a prodigious proliferation in the number of possible functional solutions to an increasing variety of biological problems. Optimal utilization of every conceivable trophic resource in lacustrine environments by just one fish family, the Cichlidae, has been achieved by eruptive evolutionary radiation within the characteristically cichlid body plan producing mechanisms which partition the diverse food resources with extraordinary efficiency therefore minimizing resource sharing. There is a direct relationship between the effectiveness of trophic resource exploitation and the functional integration of the cichlid body plan in which a minimum number of adaptive compromises are necessary to evolve optimal anatomical solutions by rapidly realizable changes.

Anatomical data presented here reveal that cichlids possess a specific kind of mosaic in which the basic percoid jaw apparatus permits unparalleled optimal adaptations by simple morphogenetic changes while unique and dramatically diverse patterns of muscular coordination involving degrees of synchrony and extensive modulating capabilities of antagonistic muscle groups have been discovered electromyographically. At the same time the highly integrated pharyngeal jaw apparatus is sufficiently specialized providing complete freedom for the jaws to evolve into refined collecting devices.

The exceptional evolutionary success of lacustrine cichlids demonstrates how rare and very specific kinds of biologically versatile morphological mosaics represent the best preadaptations for the ancestors of major new taxa. Given identical ecological conditions and temporal factors, a group of organisms possessing such rare mosaics, in which optimal biological versatility is realizable by simple evolutionary mechanisms, will dominate newly formed environments to the detriment of taxa not so endowed. (Auth. Synopsis)

76-000111 McCleneghan, K. (Calif. Dep. Fish Game, 2201 Garden Rd., Monterey 93940) VERTEBRAL COUNTS OF SOME PACIFIC MORAYS (FAMILY MURAENIDAE). *Copeia* 1976 (1): 207-210. 12 Mar. 1976. SFA 21(1).

76-000112 Varraes, W. (Rijksuniv. Gent, Inst. Dierkunde Ledegan Ckstraat 35-B-9000, Gent, Belgium) POSTEMBRYONIC DEVELOPMENT OF THE NASAL ORGANS, SACS AND SURROUNDING SKELETAL ELEMENTS IN /*SALMO GAIRDNERI*/ (TELEOSTEI: SALMONIDAE), WITH SOME FUNCTIONAL INTERPRETATIONS. *Copeia* 1976 (1): 71-75. 12 Mar. 1976. SFA 21(1).

A morphological description of the nasal organ is given during the first 97 days of postembryonic development in /*Salmo gairdneri*/ (rainbow trout), based on series of transverse microscopic sections through the head of eight stages. Special attention is given to the development of the nasal organ and to some skeletal elements, especially the cartilaginous neurocranium, palatoquadratum, os infraorbitale 1, os nasale, os supraethmoideum and os supraorbitale, and to the presence of a ligament between palatoquadratum and os antorbitale.

The functional relations (form, position and possible action) and the chronology of development of these structures are discussed. It is suggested that, apart from passive ventilation of the nasal cavity, there can be active ventilation through respiratory movements of the suspensorium, and through eye movements.

76-000113 Werns, S.; Howland, H. C. (Sect. Neuobiol. Behav., Cornell Univ., Ithaca, NY 14853) SIZE AND ALLOMETRY OF THE SACULAR AIR BLADDER OF /*GNATHONEMUS PETERSI*/ (PISCES: MORMYRIDAE): IMPLICATIONS FOR HEARING. *Copeia* 1976 (1): 200-202. 12 Mar. 1976. SFA 21(1).

PHYSIOLOGY

76-000114 Alderdice, D. F. (Fish. Mar. Serv., Pacific Biol. Stn., Nanaimo, BC V9R 5K6, Canada) SOME CONCEPTS AND DESCRIPTIONS OF PHYSIOLOGICAL TOLERANCE: RATE-TEMPERATURE CURVES OF POIKILOOTHERMS AS TRANSECTS OF RESPONSE SURFACES. *J. Fish. Res. Board Can.* 33 (2): 299-307. Feb. 1976. In English with French summ. SFA 21(1).

Precht rate curves may be considered as transects across a rate surface bounded by a Fry temperature polygon. Changes in metabolic or active capacity within the tolerance polygon approximate capacity changes within Precht's normal range of temperatures. Precht's resistance adaptations are consequences of change in capacity occurring in the zone of resistance of Fry.

The turning-point axis of Precht rate curves is assumed analogous to the axis of maximum rate at acute temperatures (test-temperature axis), using an activity surface as a model. Parallelism is suggested between this axis and the upper incipient lethal temperature boundary where the latter may be unknown.

In the standard comparison of cold-adapted and warm-adapted rates, Precht compensation types can depend on the nature of the capacity surface and on the choice of acclimation temperatures. Reasonable and paradoxical resistance adaptations reflect characteristics of the capacity surface, in particular the turning-point axis, in relation to the acclimation and acute temperature axes of measurement. Resistance adaptations appear directly related to the course of the incipient lethal boundaries on a rate surface. Further understanding of capacity surfaces probably requires that a minimum of five transects be made across a surface, rather than the two generally made for warm-adapted and cold-adapted comparisons.

In such studies, meaningful measures of acute response require extended understanding of the nature and time course of thermal acclimation, and of the potential biases imbedded in a response arising from other temperature-dependent compartments of metabolic demand. The need is demonstrated for a quantitative distinction

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between thermal resistance and tolerance in cells and microorganisms, equivalent to the incipient lethal temperature boundaries of Fry. Such determinations, above all, require that temperature level and exposure time not be confounded.

76-000115 Beltz, J. R.; Johnson, J. E.; Cohen, D. L.; Pratt, F. B. (Dep. For. Wildl. Manage., Univ. Mass., Amherst 01002) AN ANNOTATED BIBLIOGRAPHY OF THE EFFECTS OF TEMPERATURE ON FISH WITH SPECIAL REFERENCE TO THE FRESHWATER AND ANADROMOUS SPECIES OF NEW ENGLAND. Mass. Agric. Exp. Stn. Bull. No. 605. 97p. July 1974. SFA 21(1).

Citations and abstracts are given for 457 references. (RS)

76-000116 Block, R. M. EFFECTS OF TEMPERATURE AND SALINITY ON THE OSMOTIC ADJUSTMENT IN THE EURYHALINE RAINBOW TROUT, /SALMO GAIRDNERI/ RICHARDSON AND THE STENOHALINE CHANNEL CATFISH, /ICTALURUS PUNCTATUS/ (RAPINESQUE). Ph.D. dissertation, Univ. N. Dak. 177p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(10), 1975. SFA 21(1).

Channel catfish, /*Ictalurus punctatus*/, were acclimated to various temperatures (2, 10, 20, and 30 C) in both freshwater and 30 percent seawater. Rainbow trout, /*Salmo gairdneri*/, were acclimated to various temperatures (1, 10, and 20 C) in freshwater (FW), 50 percent seawater (SW), and full strength seawater under otherwise constant laboratory conditions. Isosmotic conditions (30 percent SW) did not affect hematocrit values in channel catfish as compared to FW values, although these values were reduced 50 percent in cold-adapted fish as compared to warm-adapted fish. Plasma cholesterol levels were not significantly altered by temperature or salinity, but total tissue lipids were reduced at the colder temperatures in freshwater-adapted channel catfish. Both plasma protein and glucose levels were depressed in fish held at the colder temperatures in both FW and 30 percent SW. In catfish acclimated to 2 C tissue water was increased by 3 percent above the level in fish acclimated at 30 C in FW. In 30 percent SW, tissue water was only increased by 1 percent at 2 C compared with fish held at 30 C. Plasma osmolarity, sodium and chloride levels were significantly decreased at the colder temperatures in FW-adapted fish. Plasma osmolarity, sodium and chloride levels were well regulated in fish maintained in 30 percent SW at 10, 20 and 30 C.

Potassium levels appear to be well regulated in channel catfish adapted to both FW and 30 percent SW at all temperatures. Both plasma calcium and magnesium levels were regulated in FW-adapted catfish at all temperatures.

Rainbow trout acclimated to FW did not show change in hematocrit, plasma cholesterol, protein, urea, or tissue lipid levels at any of the acclimation temperatures. The erythrocyte number and tissue lipid levels were increased in fish acclimated to 100 percent SW held at the coldest temperature, but plasma cholesterol and glucose levels remained unchanged. Plasma urea levels in SW-adapted rainbow trout were 2-fold higher at 1 and 10 C than other experimental FW-adapted rainbow trout display excellent osmoregulatory ability with respect to tissue water, plasma osmolarity, sodium, chloride, potassium, calcium and magnesium levels at all acclimation temperatures. (From Auth. Abstr.)

76-000117 Cheng, P.-C. BIOENERGETICS OF UTAH CHUB AND RAINBOW TROUT. Ph. D. dissertation, Univ. Idaho 69p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(6), 1975. SFA 21(1).

Feeding, assimilation, growth and metabolic rates of Utah chub (*Gila atraria*) and rainbow trout (*Salmo gairdneri*) were determined at four food rations (maximum, 2/3 maximum, 1/3 maximum and zero ration). Oregon moist pellet was used as food in the chub test, and fish flesh was used for food in the trout test.

Maximum food consumption rates of Utah chub at 8.0, 12.0, 16.0 and 20.0C were 62.7, 101.1, 144.6 and 219.9 cal/kcal fish/day, respectively. Utah chub consumed the largest amount of food at 20C, and least at 8C. Maximum food consumption rate of rainbow trout at 10.0, 12.8, 15.6 and at regulated temperature fluctuations of 10.0-15.6C were 60.8, 73.6, 60.1 and 75.8 cal/kcal fish/day. Rainbow trout raised in 12.8 and 10.0-15.6C consumed more of the available food than the trout raised in 10.0 and 15.6C. Utah chub assimilated about 62 to 79 percent of the Oregon moist pellet fed. Food assimilation by chub was positively related to temperature ($p \leq 0.05$) and inversely related to food ration ($p \leq 0.05$). Rainbow trout assimilated about 97 percent of fish flesh regardless of the variations in temperature and food ration. At any given food ration, growth of Utah chub was maximum at 20 C and least at 8C. Growth rate of rainbow trout was affected primarily by the amount of food intake and not by temperature.

Fluvial St. Joe River cutthroat trout consumed food at the rate of 12.6, 8.9 and 8.7 cal/kcal fish/day during the first, second and third year of growth, respectively. As these values were considerably less than the mean maximum food ration of the experimental rainbow trout, I thus conclude that growth of St. Joe River cutthroat trout was limited by food intake.

Metabolic rate (T) of Utah chub and rainbow trout were linearly related to the amount of food intake (R), and may be described by the equations $T = 0.31R - 0.65$ and $T = 0.71R + 2.22$ ($r = 0.99$), respectively. Maximum metabolic rates obtained from the feeding-growth method were about three times greater than the reported maximum respiration rate of Utah chub and rainbow trout. Reported respiration rates of Utah chub and rainbow trout were comparable to the metabolic rates of fish fed less than 50 percent of the maximum food ration.

76-000118 Dorfman, D.; Heyl, A. (Monmouth Coll., West Long Branch, NJ 07764) OCCURRENCE OF A HERMAPHRODITIC WHITE PERCH (*MORONE AMERICANA*). Prog. Fish-Cult. 38 (1): 45. Jan. 1976. SFA 21(1).

A hermaphroditic specimen of white perch (*Morone americana*) was collected from a flume connecting a freshwater lake with periodic saltwater intrusions and the ocean in New Jersey. Dissection of the apparently normal fish revealed unequally sized ovotestes. The left ovotestis weighed 33.2 g and the right weighed 3.3 g; histological sections clearly showed the difference in structure of the male and female portions of the ovotestes. Spermatazoa appeared normal but the small size of the ova suggests that the ovarian portions were not functional.

76-000119 Driedzic, W. R.; Kiceniuk, J. W. (Dep. Physiol., M.S. Hershey Med. Cent., Pa. State Univ., Hershey 17033) BLOOD LACTATE LEVELS IN FREE-SWIMMING RAINBOW TROUT (*SALMO GAIRDNERI*) BEFORE AND AFTER STRENUOUS EXERCISE RESULTING IN FATIGUE. J. Fish. Res. Board Can. 33 (1): 173-176. Jan. 1976. In English with French summ. SFA 21(1).

Rainbow trout (*Salmo gairdneri*) were exercised to fatigue in a series of 60-min stepwise increasing velocity increments. There was no increase in blood lactate concentration, serially sampled during swimming by means of indwelling dorsal and ventral aortic catheters,

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at velocities as high as 93 percent of critical velocity of individuals. The data show that under these conditions the rate of production of lactate by white muscle, at less than critical velocities, is minimal or that the rate of elimination of lactate from white muscle is equal to its rate of utilization elsewhere. Immediately following fatigue blood lactate level increases rapidly. During the recovery period there appears to be a net uptake of lactate by the gills.

76-000120 Duman, J. G. THE ROLE OF MACROMOLECULAR ANTIFREEZE SOLUTES IN FREEZING RESISTANCE OF COLD WATER FISHES. Ph.D. dissertation, Univ. Calif. (San Diego) 114p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. SFA 21(1).

The freezing point of the blood serum of most marine teleost fishes ranges between -0.5 to -0.8 C, while that of seawater of 35‰ salinity is -1.86 C. Therefore, there are large areas of the oceans where teleosts could freeze in winter unless some adaptation to prevent freezing has evolved. Certain antarctic fishes of the family nototheniidae are known to produce a glycoprotein antifreeze which lowers the freezing point of their body fluids below that of the water which they inhabit. A few northern fishes were thought to have a similar adaptation.

This study describes several new species, some distantly related phylogenetically, which were shown to produce a macromolecular antifreeze. It is therefore likely that the ability to produce a macromolecular antifreeze in response to sub-zero water temperatures has evolved independently several times. Indeed, the composition of the antifreeze produced by the winter flounder, *Pseudopleuronectes americanus*, is quite different from that of the antarctic nototheniid fishes.

Certain northern species were shown to undergo a circannual cycle of antifreeze production in winter followed by antifreeze loss in summer. This cycle was entrained by environmental water temperatures and in at least one instance (*Pseudopleuronectes americanus*) by a combination of temperature and photoperiod. Depending on the species, the complete loss of antifreeze from the serum took from 2 to 5 weeks during warm acclimation. It required approximately one month for the fish to produce enough antifreeze to become freeze resistant during cold acclimation. (From Auth. Abstr.)

76-000121 Edsall, T. A.; Rottiers, D. V. (U.S. FWS, Great Lakes Fish. Lab., Ann Arbor, MI 48105) TEMPERATURE TOLERANCE OF YOUNG-OF-THE-YEAR LAKE WHITEFISH, *COREGONUS CLUPEAIFORMIS*. J. Fish. Res. Board Can. 33 (1): 177-180. Jan. 1976. In English with French summ. SFA 21(1).

The ultimate upper lethal temperature of young-of-the-year lake whitefish, *Coregonus clupeaformis*, was 26.65 C; this value is closely similar to that reported for yearling bloaters, *Coregonus hoyi* (26.75 C) and young-of-the-year lake herring, *Coregonus artedii* (26.0 C).

76-000122 Giles, M. A.; Vanstone, W. E. (Dep. Biol. Sci., Sir George Williams Campus of Concordia Univ., Montreal, PQ H3G 1M8, Canada) CHANGES IN OUBAIN-SENSITIVE ADENOSINE TRIPHOSPHATASE ACTIVITY IN GILLS OF COHO SALMON (*ONCORHYNCHUS KISUTCH*) DURING PARR-SMOLT TRANSFORMATION. J. Fish. Res. Board Can. 33 (1): 54-62. Jan. 1976. In English with French summ. SFA 21(1).

The effects of incubation temperature, pH, sodium, potassium, and ATP concentration, and ouabain on the activity of Na⁺-K⁺-activated ATPase of the gills of seawater-adapted juvenile coho salmon

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(/Oncorhynchus kisutch/) were determined. The temperature and pH optima were 40 C and 7.4, respectively. The apparent K_m for ATP at equimolar Mg^{++} concentration was 0.2 mM at Na^+ and K^+ concentrations of 100 and 20 mM, respectively. Maximal enzyme activity for Na^+ concentrations of 10.50 and 100 mM occurred at K^+ concentrations of 12.5, 15.0, and 20.0 mM, respectively. The $K(i)$ for ouabain was 2×10 to the -6th M and 7×10 to the -6th for K^+ concentrations of 10 and 20 mM, respectively.

A large portion (up to 60 percent) of the ouabain-sensitive ATPase activity in freshwater fish was activated by sodium ions in the absence of potassium ions (Na^+ -activation). Exposure to sea water resulted in a large increase in total ouabain-sensitive activity and a sharp decrease in the proportion of sodium activation. These changes occurred within 14 days after transfer to full strength sea water.

On a seasonal basis, total ouabain-sensitive enzyme activity in juvenile freshwater coho was low (less than 5 μ mol Pi/mg N per h) to the end of November, increased to a peak (over 125 μ mol Pi/mg N per h) in mid-January, and subsequently declined by late February. A slow, steady rise in activity occurred during the smolting period of March and April and the relative contribution of sodium ions to the total activity declined in this period.

76-000123 Hauser, W. J. (Imperial Valley Field Stn., 1004 East Holton Rd., El Centro, CA 92243) A HERMAPHRODITIC MOUNTAIN SUCKER, /CATOSTOMUS PLATYRHYNCHUS/. Copeia 1975 (4): 775. 31 Dec. 1975. SFA 21(1).

76-000124 Horkel, J. D.; Pearson, W. D. (Dep. Wildl. Fish. Sci., Texas A & M Univ., College Station 77843) EFFECTS OF TURBIDITY ON VENTILATION RATES AND OXYGEN CONSUMPTION OF GREEN SUNFISH, /LEPOMIS CYANELLUS/. Trans. Am. Fish. Soc. 105 (1): 107-113. Jan. 1976. SFA 21(1).

Ventilation and oxygen consumption rates of green sunfish exposed to bentonite clay suspensions were measured at 5, 15, 25, and 35 C. Ventilation rates were not affected by bentonite clay suspensions below 2,125 FTU (Formazin Turbidity Units) at 5 C, 1,012 FTU at 15 C, and 898 FTU at 25 C. At turbidity levels exceeding 1,012 FTU at 15 C and 898 FTU at 25 C ventilation rates increased 50-70 percent. Tests were inconclusive at 35 C due to high mortality. Oxygen consumption rates were not affected by turbid suspensions of up to 3,500 FTU at any of the four temperatures. Evidence suggests that increased ventilation rates under highly turbid conditions are a means of compensating for reduced respiratory efficiency and a strategy for maintaining a constant oxygen uptake. The costs of increased ventilation rates were probably met by a reduction in activity.

76-000125 Katz, L. M. LABORATORY STUDIES ON DIET, GROWTH, AND ENERGY REQUIREMENTS OF /FUNDULUS HETEROCLITUS/ (LINNAEUS). Ph.D. dissertation, Univ. Del. 81p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(5), 1975. SFA 21(1).

The growth and energy requirements of /Fundulus heteroclitus/ offered diets of animal material, plant material and detrital material were studied under laboratory conditions. The fish used in this study were captured in Canary Creek and surrounding marsh, Lewes, Delaware. The results of the study indicate that this species could not be sustained under diets of plant or detrital material. Growth rates of fish fed various rations of animal material indicate that optimum conversion efficiency at 20°C occurs at a ration of approximately 15 percent of body wt/day. Comparisons of laboratory growth rates with previously estimated rates in the field demonstrate that higher growth

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rates occur in the laboratory. A model of energy utilization in Canary Creek, based on laboratory findings, estimates that the energy requirements, for maintenance of the Canary Creek population of *F. heteroclitus*/, totals 4185 calories/M²/day. Energy requirements for the observed summer production in Canary Creek is estimated to be approximately 450,000 calories/M² over a 70 day period.

76-000126 Kirk, W. L. (Texas Instruments, Inc., P.O. Box 4333, New Windsor, NY 12550) EFFECT OF SODIUM CHLORIDE ON BLOOD LACTATE AND PH OF CHANNEL CATFISH DURING RECOVERY FROM HYPOXIA. Prog. Fish-Cult. 38 (1): 48-50. Jan. 1976. SFA 21(1).

Blood pH and lactate were measured in channel catfish (*Ictalurus punctatus*/) during recovery in fresh water and in 0.7 percent sodium chloride solutions after periods of acute hypoxia (9-12 min). Blood pH returned to pre-stress levels within 12 h at 15 C and 4-6 h at 25 and 26 C; the rate of recovery of fish in fresh water did not differ from that of fish in salt water. Lactate returned to pre-stress levels more slowly than did pH, and lactate levels of fish recovering in salt solution were higher during early stages of recovery than were those of fish in fresh water. The addition of sodium chloride (0.7 percent) to the recovery water did not appear to increase the rate of return of blood pH and lactate to pre-stress levels.

76-000127 Lutz, P. L. (Sch. Biol. Sci., Bath Univ., Bath BA2 7AY, England) ADAPTIVE AND EVOLUTIONARY ASPECTS OF THE IONIC CONTENT OF FISHES. Copeia 1975 (2): 369-373. 23 May 1975. SFA 21(1).

From a table of the total ionic content of plasma of the major fish groups it is seen that, even when excluding the hagfish, there is a wide range in values (180-520 mM). However, individual groups are much more closely defined, and have characteristic values, with the result that large variations are seen in what can be regarded as the degree of an ionic adaptation to the environment. In the sea, elasmobranchs (520 mM) have more work to perform in ion maintenance than the hagfish (1070 mM) but less than the marine sturgeons (270 mM), while in freshwater the dipnoi and polypteroids (180-200 mM) maintain substantially lower gradients than the freshwater teleosts and holosteans (270 mM). It is suggested that physiological innovations evolved in a given habitat are associated with a particular internal ionic environment and that this has resulted in some degree of internal ionic dependence. The concept of "dependence limits" is used to interpret the environmental history of the various fish groups. (Auth. Summ.)

76-000128 Mettee, M. F., Jr. A STUDY ON THE REPRODUCTIVE BEHAVIOR, EMBRYOLOGY, AND LARVAL DEVELOPMENT OF THE PYGMY SUNFISHES OF THE GENUS /ELASSOMA/. Ph.D. dissertation, Univ. Ala. 139p. 1974. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

/Elassoma okefenokee/, /E. evergladei/, /Elassoma/ species, and /E. zonatum/ were spawned and raised in the laboratory. Extensive observations revealed that the spawning behavior of the elassomid species was very similar. This behavior differed from that of the centrarchids in the following ways.

1. Ellassomid fishes did not spawn in a nest on the bottom.
2. Eggs were always deposited on aquatic vegetation above the bottom when the proper spawning medium was present.
3. The courtship behavior of the male ellassomids was more complex than that of most centrarchids.
4. Contrary to the inclined position assumed by all female centrarchids during spawning, both male and female ellassomid fishes remained in the upright position throughout the entire spawning act.

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In addition to these behavioral characteristics, other investigators noted sufficient morphological and chromosomal differences to justify placing the genus *Elassoma* in a separate family, the Elassomatidae.

A composite description of the embryology of *Elassoma* was based on the observation of eggs from 17 spawns of *Elassoma okefenokee*, 10 spawns of *E. evergladei*, 6 spawns of *Elassoma* species and 24 spawns of *E. zonatum*. Development times were 82 hours for *Elassoma okefenokee* at 23 C, 65 hours for *E. evergladei* at 25.5 C, 72 hours for *Elassoma* species at 23.5 C, and 11/ hours for *E. zonatum* at 21 C. The time period necessary for the newly hatched prclarvae to reach young adult size (approximately 16 millimeters standard length) was 160 days for *Elassoma okefenokee*, 90 days for *E. evergladei*, 325 days for *Elassoma* species, and 100 days for *E. zonatum*. Fin development was completed at standard lengths of 8.0 to 9.0 millimeters for *Elassoma okefenokee*, 6.4 to 7.0 millimeters for *E. evergladei*, 5.3 to 5.7 millimeters for *Elassoma* species, and 8.0 to 8.5 millimeters for *E. zonatum*. At the end of metamorphosis, the fishes of all four species were covered with cycloid scales. (From Auth. Abstr.)

76-000129 Misitano, D. A. (NMFS, 2725 Montlake Blvd. East, Seattle, WA 98112) SIZE AND STAGE OF DEVELOPMENT OF LARVAL ENGLISH SOLE, *PAROPHRYS VETULUS*, AT TIME OF ENTRY INTO HUMEOLDT BAY. Calif. Fish Game 62 (1): 93-98. Jan. 1976. SFA 21(1).

76-000130 Shrode, J. B. GENETIC AND TEMPERATURE EFFECTS ON DEVELOPMENT OF THE AMARGOSA PUPFISH. Ph.D. dissertation, Ariz. State Univ. 70p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. SFA 21(1).

Adult *Cyprinodon n. nevadensis* were collected from Saratoga Springs, Death Valley National Monument, California, and bred in the laboratory at 28 C, 16L 8D. Eggs were incubated at constant temperatures and at diel fluctuating temperatures. Greater than 50 percent normal hatch occurred between constant temperatures 20 and 36 C and at fluctuating temperatures 28-20 C, 36-28 C and 38-30 C. Eggs were able to withstand a daytime high temperature, 38 C, when the temperature was allowed to drop at night, which was not tolerable under constant conditions. The tolerance limits for normal egg development parallel the temperatures reported in the literature for breeding behavior observed in the field.

Critical thermal maxima of young fish were consistently higher than those of older fish acclimated under the same conditions. The tolerance to high temperature is apparently lowest during the egg stage, highest in young fish and intermediate in large adults.

There was no significant difference in number of vertebrate among any of the following experimental groups on which counts were made: fish which had been incubated at 1) constant temperatures 20 through 36 C, 2) diel fluctuating temperature 28-20 C, 36-28 C, 38-30 C, 3) photoperiods 16L 8D, 24L, 24D, at temperatures 24, 28, and 36 C, and 4) adults collected from the marsh and spring pond at Saratoga Springs. It may be advantageous for the pupfish to have reduced sensitivity to temperature in affecting vertebral number by reducing developmental abnormalities which might otherwise occur under widely fluctuating temperatures in the natural habitat.

76-000131 Speiler, R. E. CIRCADIAN AND SEASONAL SERUM PROLACTIN LEVELS IN SOME FRESHWATER AND ESTUARINE FISHES: ENDOCRINOLOGICAL, ECOLOGICAL, AND MARICULTURAL IMPLICATIONS. Ph.D. dissertation, La. State Univ. Agric. Mech. Coll. 69p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(7), 1976. SFA 21(1).

In an investigation of a possible stress response of serum prolactin concentrations in fish, serially sampled goldfish (*Carassius auratus*) did not have significant variations in serum prolactin between 30 s and 3 min after initial capture. A marked decrease was noted 9-17 min after initial capture followed by a recovery at 30-48 min. Although there was a circadian variation in prolactin concentration, the pattern of response to capture and sampling did not vary significantly among the three testing periods (beginning, middle and end of a 12 h daily photoperiod). The photoperiod was demonstrated to influence the circulating prolactin rhythm. Gulf killifish (*Fundulus grandis*) acclimated to one of two daily photoperiods (15L:9D or 9L:15D), had differences in circadian rhythms of serum prolactin. The prolactin rhythm did not cause a circadian salinity preference in Gulf killifish (*Fundulus grandis*). However, fish acclimated to a 15L:9D photoperiod selected less saline waters than conspecifics acclimated to either 12L:12D or 9L:15D. Seasonal changes in the prolactin rhythm were noted. The form of the circadian rhythm of serum prolactin and the time of day of increasing prolactin titers differed among striped mullet (*Mugil cephalus*) collected at three different seasons (winter, summer, fall). These differences did not show a consistent correlation with any aspect of the photoperiod and suggest that the time interval from environmental entraining stimulus to hormone release may undergo seasonal changes and may be controlled by an endogenous circannual mechanism. These results have specific implications to endocrinologists and ecologists interested in hormonal and/or environmental integration of fishes. They may also offer mariculturists insights into methods for controlling growth and reproduction in fishes. (From Auth. Abstr.)

76-000132 Spieler, R. E.; Meier, A. H. (Milwaukee Public Museum, Milwaukee, WI 53233) SHORT-TERM SERUM PROLACTIN CONCENTRATIONS IN GOLDFISH (*CARASSIUS AURATUS*) SUBJECTED TO SERIAL SAMPLING AND RESTRAINT. J. Fish. Res. Board Can. 33 (1): 183-186. Jan. 1976. In English with French summ. SFA 21(1).

Serum prolactin concentrations in serially sampled goldfish (*Carassius auratus*) did not vary significantly between 30 s and 3 min after initial capture. A marked decrease in prolactin concentration was noted 9-17 min after initial capture followed by a recovery at 30-48 min. Although there was a circadian variation in prolactin concentration, the pattern of response to capture and sampling did not vary significantly among the times tested.

76-000133 Strommen, C. A.; Rasch, E. M.; Balsano, J. S. (Dep. Biol., Marquette Univ., Milwaukee, WI 53233) CYTOGENETIC STUDIES OF *POECILIA* (PISCES). IV. EPITHELIAL CELL BIOPSIES TO IDENTIFY TRIPLOID FEMALES ASSOCIATED WITH *POECILIA FORMOSA*. Copeia 1975 (3): 568-572. 5 Aug. 1975. SFA 21(1).

76-000134 Symons, P. E. K.; Metcalfe, J. L.; Harding, G. D. (Fish. Mar. Serv., Biol. Stn., St. Andrews, NB E0G 2X0, Canada) UPPER LETHAL AND PREFERRED TEMPERATURES OF THE SLIMY SCULPIN, /COTTUS COGNATUS/. J. Fish. Res. Board Can. 33 (1): 180-183. Jan. 1976. In English with French summ. SFA 21(1).

The upper lethal and preferred (96-h LT50) temperatures of slimy sculpin (/Cottus cognatus/) acclimated at 20 C are 25.0 and 13 C, respectively.

76-000135 Thatcher, T. O. SOME EFFECTS OF DISSOLVED OXYGEN CONCENTRATION ON FEEDING, GROWTH AND BIOENERGETICS OF JUVENILE COHC SALMON. Ph.D. dissertation, Oreg. State Univ. 78p. 1975. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. SFA 21(1).

The effects of three levels of dissolved oxygen (8, 5, and 3 mg/l) upon the feeding, growth and bioenergetics of juvenile coho salmon, /Oncorhynchus kisutch/ (Walbaum), were determined in laboratory studies. Experiments with individual fish were conducted during the summer, fall and spring to measure rates of food consumption, standard metabolism, waste production, activity-specific dynamic action, and growth. House fly larvae were fed to the young salmon and the temperature was kept constant year-round at 15 C.

The results indicated that differences due to the dissolved oxygen concentration were not great. Food consumption rate and the slope of growth rate curves were reduced only at 3 mg/l dissolved oxygen and only at near maximum food consumption rates which appear to be higher than juvenile coho salmon generally encounter in nature. However, normal competition for food and space in stream life (not present in these experiments) would be expected to curtail feeding in naturally occurring populations of juvenile cohos exposed to dissolved oxygen levels near 3 mg/l.

Energy budgets were constructed from caloric determinations of the various uses made of energy in the consumed food. These revealed that the reduced slope of the growth curve exhibited by 3 mg/l fish at near maximum feeding levels was due to sharp increases in energy requirements for activity-specific dynamic action. These energy budgets also offered the explanation that the greater loss of weight by the starved juvenile cohos kept at 8 mg/l dissolved oxygen (as compared to those kept at 3 and 5 mg/l) was due to their greater activity.

Juvenile cohos kept at 5 mg/l dissolved oxygen in these studies grew at least as well as those at 8 mg/l. Again, however, this was considered to be an artifact of this experimental procedure. Fish reported upon here were not required to expend energy in competition for food and space as are those living in nature.

76-000136 Todd, E. S. (Nordlysvej 9, Arhus 8200 N, Denmark) VERTICAL MOVEMENTS AND DEVELOPMENT OF THE PROLARVAE OF THE ELEOTRII FISH, /DORMITATOR LATIFRONS/. Copeia 1975 (3): 564-568. 5 Aug. 1975. SFA 21(1).

76-000137 Valtonen, J. O. T. SEASONAL PHENOMENA OF TEMPERATURE SELECTION, GONADAL CYCLE AND LIVER CARBOHYDRATE METABOLISM IN THE WHITEFISH, /COREGONUS NASUS/ (PALLAS), /SENUS/ SVARDSON. Ph.D. dissertation, Oulu Univ. (Finland) 1974. From Diss. Abstr. Int. B Sci. Eng. 36(9), 1976. SFA 21(1).

The adult whitefish studied select their environment during the summer so that a temperature of 12°C in the thermocline is found to be the upper limit for vertical movement for the majority of the swarm. These fish also leave the coastal waters for the deeper, cooler open sea when the comparatively warm epilimnion water reaches the bottom

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while the underyearlings are still encountered in the warm epilimnion in June-July. In October spawning fish and those preparing to spawn have very little food in their alimentaries. In November-December the amount of food is high in all fish. During the months February-March the fish starve at least to some extent. During the summer the amount of food varies, reflecting to a considerable degree changes in its availability. The gonads develop rapidly, judging by their weight, beginning at the end of June or at least in July. The glycogen content in the liver reached comparatively high values for the suborder /Salmonoidei/ during the winter. It increased rapidly towards the end of October and in November, as the water cooled and the ice cover formed, coinciding with high food content in the stomach. The male fish preparing to spawn have exceptionally high liver glycogen by the beginning of October, the spawning month. In spring the glycogen content decreases considerably, however, although the temperature of the sea water scarcely increases at all, though the low glycogen content characteristic of the summer, is not found until after the ice cover has melted. The available temperature acclimation data suggest that the high glycogen content in the liver is not only connected with the cold environment, but that seasonal adjustment controlled by exogenic and endogenic factors also plays a significant part in inducing these changes. Evidence of such a controlling system is also found when comparing enzyme activities measured at cold and warm incubation temperatures during the seasons. (From Auth. Abstr.)

GENETICS, VARIATION STUDIES AND HYBRIDIZATION

76-000138 Baglin, R. E., Jr. SUBPOPULATIONS OF WHITE BASS, /MORCNE CHRYSOPS/ (RAFINESQUE), IN LAKE TEXOMA. Ph.D. dissertation, Univ. Okla. 113p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(4), 1975. SPA 21(1).

This study was conducted from 1969 through 1972 to determine whether two distinct subpopulations of white bass were present in Lake Texoma. The fecundity of white bass ranged from 61,700 to 510,000 ova in the Red River, and from 111,900 to 452,300 ova in the Washita River. Adjusted mean values, determined by covariance analysis, of the regressions of fecundity-length, fecundity-weight, and fecundity-age were significantly different. Eight morphometric characters were measured on Red and Washita river pre-spawning fish. Regressions of measurements of seven of these characters versus total length were analyzed by covariance analysis. Five proved useful for separating the two populations. Counts conducted on white bass from each river showed that the number of rays in the left pectoral fin was significantly different for the 1968 year class. A body-scale relationship was determined, and an analysis of covariance revealed no significant difference between the two localities. The length-weight relationship was determined, and an analysis of covariance revealed a significant difference in the regression coefficients. Most growth occurred during the first two years of life. Acrylamide gel electrophoresis was used to analyze blood protein patterns. Differences were detected in the protein bands for each sex between the two localities. On the basis of this study, heterogeneity among the white bass populations of the Red River Arm and the Washita River Arm of Lake Texoma was established. (From Auth. Abstr.)

76-000139 Copeman, D. G. POPULATION DIVERSITY IN THE RAINBOW SMELT, /OSMERUS EFERLANUS MORCAX/ (MITCHELL, 1914) (SALMONOIDEA: OSMERIDAE) AS REVEALED BY CANONICAL AND DISCRIMINANT FUNCTION ANALYSES ON MORPHOMETRIC, MERISTIC AND ESTERASE DATA. Ph.D. dissertation, Mem. Univ. Newfoundland 1973. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. [To obtain a microfiche copy order film No. 16349 from the National Library of Canada at Ottawa.] SFA 21(1).

Thirteen smelt populations were sampled during their spawning runs. Morphometric, meristic and biochemical data were recorded for each population. These data were analysed separately and together to obtain a measure of the degree of difference between the populations. Appropriate statistical methods were employed throughout the study.

It was found that there were differences between the samples on the basis of any type of data and that the differences were real. Individuals could be identified as to population of origin with an average accuracy of 93.4 per cent. The differences between small and normal forms were very large and the marine and freshwater smelt were also distinct. There were also indications that smelt populations vary, not only from place to place but from year to year. Classifications derived from the data indicated that environmental factors may be important in accounting for the observed differences between populations. A considerable amount of redundancy was observed in the data.

The work forms a comprehensive model for the investigation and identification of populations of a species. Methods are proposed for handling data for which the standard analyses of population genetics are not applicable. (From Auth. Abstr.)

76-000140 Echelle, A. A.; Echelle, A. F.; Smith, M. H.; Hill, L. G. (Biol. Dep., Baylor Univ., Waco, TX 76706) ANALYSIS OF GENIC CONTINUITY IN A HEADWATER FISH, /ETHEOSTOMA RADIOSUM/ (PERCIDAE). Copeia 1975 (2): 197-204. 23 May 1975. SFA 21(1).

Variation in lactate dehydrogenase, esterase and glutamate oxalacetic transaminase isozymes, as detected by starch gel electrophoresis, is described for the orangebelly darter, /Etheostoma radiosum/, over its entire geographical range. A high degree of interdrainage differentiation occurred in allelic frequencies for two polymorphic enzymes. There is no known environmental correlate of the observed variation. The patterns of intradrainage variation suggest very little gene flow between populations in different drainages. The occurrence of certain rare alleles at several localities seems due to interbreeding with /Etheostoma spectabile/. This is highly local in effect and is relatively unimportant in accounting for genetic divergence in /E. radiosum/.

76-000141 Eckroat, L. R. (Behrend Coll., Erie, PA 16510) HETEROZYGOSITY AT THE LACTATE DEHYDROGENASE-A LOCUS IN GRASS PICKEREL, /ESOX AMERICANUS VERMICULATUS/. Copeia 1975 (3): 466-470. 5 Aug. 1975. SFA 21(1).

Electrophoretic analyses of the lactate dehydrogenase isozymes of the grass pickerel, /Esox americanus vermiculatus/ (Lesueur) indicates that they exist in three homopolymeric forms A(4), B(4), and E(4). Three codominant alleles are suggested at the A locus, theoretically giving six phenotypes, four of which have been observed in a natural population.

Allele frequency analyses involving the LDH-A locus indicates that the results of this study are consistent with the random segregation of three alleles at a single locus.

Intra-stream, inter-year heterogenetics of LDH-A allele frequencies were statistically insignificant implying stability of gene frequencies. Intra-stream, inter-sampling site heterogenetics

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indicated that within the sampling area the population is genetically uniform.

76-000142 Franzin, W. G. GENETIC STUDIES OF PROTEIN VARIANTS AND THEIR USE IN A ZOOGEOGRAPHIC STUDY OF LAKE WHITEFISH, *COREGONUS CLUPEAFORMIS* (MITCHELL) IN WESTERN CANADA. Ph.D. dissertation, Univ. Manitoba 1974. From Diss. Abstr. Int. B Sci. Eng. 35(9), 1975. SFA 21(1). [Obtain microfiche copy from the National Library of Canada at Ottawa.]

Genetic studies were undertaken to establish the bases of four electrophoretically polymorphic proteins in lake whitefish *Coregonus clupeaformis*. These biochemical characters were then used to investigate zoogeographic problems in lake whitefish which had been posed as a result of morphological study by other workers.

Breeding experiments revealed the genetics of the electrophoretic phenotypes of glyceral-3-phosphate dehydrogenase (G-3-PDH) isozymes from white muscle.

All biochemical data were used collectively to test an hypothesis, developed from morphological evidence, that lake whitefish existed in at least two refugia during the Wisconsin glaciation, and that the variability seen among lake whitefish populations in Western Canada is at least partly due to a post-glacial admixture of two or more discrete stocks. The biochemical observations all revealed a break in gene frequencies at the periphery of the Yukon River watershed which is roughly consistent with morphological observations. Biochemical data suggest that gene flow in lake whitefish has been unidirectionally out of the Yukon River watershed. Possible postglacial routes of fishes originating from different glacial refugia are proposed on the basis of biochemical data combined with information on gillraker numbers and the distributions of other freshwater fish species. Local anomalies in gene frequencies, as compared with general patterns, apparently reflect combinations of founder effect, isolation, genetic drift and/or selection.

A tentative chronology, based on lake whitefish biochemical data and geological information, was devised to explain the post-glacial dispersal and distribution of lake whitefish and other freshwater fishes in the study area. (From Auth. Abstr.)

76-000143 Gall, G. A. E. (Univ. Calif., Davis 95616) GENETICS OF REPRODUCTION IN DOMESTICATED RAINBOW TROUT. J. Anim. Sci. 40 (1): 19-28. 1975. SFA 21(1).

A population consisting of parental, F(1), F(2) and backcrosses among two domestic strains of rainbow trout was used to estimate genetic parameters of reproductive performance for hatchery cultured stocks. Data were collected for post-spawning body weight, volume of eggs spawned, egg size, egg number and eggs per 100 g body weight for a total of 1,604 2-year-old female progeny. Heritabilities estimated from full-sub comparisons were similar for all five traits and equal to about $.20 \pm .05$. Dominance and epistatic variance was evident for all traits except number of eggs for which genetic variation appeared to be primarily additive. The coefficient of variation was lowest for egg size (18 percent), intermediate for body weight (23 percent) and egg number (25 percent) and highest for egg volume (28 percent) and eggs per unit body weight (30 percent).

Genetic, environmental and phenotypic correlations among the traits were estimated. Generally, egg volume was highly correlated with egg number ($.77 \pm .07$), egg size ($-.55 \pm .12$) and body weight ($.56 \pm .11$), however, egg volume and number were correlated arithmetically. Environmental correlations of egg volume with egg size and body weight also showed a positive relationship but were low. The correlation with egg number was equal to the genetic correlation. The genetic

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correlations for body weight with egg size and egg number were $.46 \pm .13$ and $.39 \pm .14$, respectively. Egg size was estimated by the volumetric method so negative correlation estimates indicate a positive relationship. The environmental correlation between body weight and egg size was zero. The genetic correlation between egg number and egg size was small and positive while the environmental correlation was about .20. Egg size showed a strong genetic correlation with eggs per unit body weight ($.47 \pm .13$) while the environmental correlation was only .26. The phenotypic correlations were generally midway between estimates of the genetic and environmental correlation and the three always carried the same sign. It was suggested that selection for egg volume may be the most effective means of improving reproductive performance. (Auth. Summ.)

76-000144 Hay, D. E. ECOLOGICAL GENETICS OF THREESPINE STICKLEBACKS (*GASTROSTEUS*). Ph.D. dissertation, Univ. British Columbia 1974. From Diss. Abstr. Int. E. Sci. Eng. 35(11), 1975. [Order microfiche copy from the National Library of Canada at Ottawa.] SFA 21(1).

The threespined stickleback (*Gasterosteus aculeatus*/ L.) is a highly varied and widely distributed species of small fish. Throughout much of its range there are two distinct forms: a marine or anadromous form, */trachurus/*, with 30-35 lateral bony plates (or scales), and a freshwater form, */leiurus/*, with 7, or fewer, plates. In some areas another form, called */semiarmatus/*, with intermediate plate numbers, is abundant.

Previous studies have emphasized the number of lateral plates as a criterion of phenotypic assessment. However, this criterion is arbitrary and can be misleading. Therefore, in this study, new criteria are described that permit distinction of phenotypes by the presence or absence of certain, individual plates. */Leiurus/* and */semiarmatus/*, previously defined by the number of plates, are re-defined: all */semiarmatus/* possess a particular plate that is absent in */leiurus/*. All */semiarmatus/* can be unequivocally distinguished from */leiurus/*, although there is considerable phenotypic variation within each group. (From Auth. Abstr.)

76-000145 Howell, W. M.; Villa, J. (Dep. Biol., Samford Univ., Birmingham, AL 35209) CHROMOSOMAL HOMOGENEITY IN TWO SYMPATRIC CYPRINID FISHES OF THE GENUS */RHINICHTHYS/*. Copeia 1976 (1): 112-116. 12 Mar. 1976. SFA 21(1).

The sympatric cyprinid fishes, */Rhinichthys atratulus/* and */R. cataractae/*, have never been known to hybridize in nature. However, genetic compatibility has been confirmed as the two species can be freely hybridized in the laboratory. Our cytological studies revealed that both species have a diploid chromosome number of 50 and that there are no apparent gross karyotypic differences which might account for their reproductive isolation in nature. Life history data suggest that the barriers to natural hybridization are probably behavioral and ecological, not genetic.

76-000146 LeGrande, W. H. (Mus. Zool., Ohio State Univ., Columbus 43210) KARYOLOGY OF SIX SPECIES OF LOUISIANA FLATFISHES (*/PLEURONECTIFORMES: OSTEICHTHYES/*). Copeia 1975 (3): 516-522. 5 Aug. 1975. SFA 21(1).

Karyotypes of six flatfish species from Louisiana representing three families varied from $2n = 28$ to $2n = 48$. Fundamental chromosome number varied from 48 to 70. Karyotypes were established for the following species: */Paralichthys lethostigma/* $2n = 48$, */Etropus crossotus/* $2n = 38$ and */Citharichthys spilopterus/* $2n = 28$ in Bothidae; */Trinectes maculatus/* and */Achirus lineatus/* $2n = 40$ in Soleidae; */Symphurus*

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plagiusa/ $2n = 45$ (males)-46 (females) in Cynoglossidae. The broad range of karyotypic variation between species and families indicates that karyotypes will probably provide useful information in studying evolutionary relationships among pleuronectiforms.

76-000147 Maclean, J. A. VARIATION AND NATURAL SELECTION IN A POPULATION OF STICKLEBACKS (*GASTEROSTEUS*). Ph.D. dissertation, Univ. British Columbia 1974. From Diss. Abstr. Int. B Sci. Eng. 35(11), 1975. [Order microfiche copy from the National Library of Canada at Ottawa.] SFA 21(1).

Threespine sticklebacks are genetically polymorphic for the number and arrangement of bony plates on the sides of the body. The adaptive significance and maintenance of plate variation was investigated in Heisholt Lake, a small British Columbia lake with two separate basins. The population contains the low plated, partially plated, and completely plated freshwater morphs of threespine sticklebacks, and plate number varies considerably within morphs.

Frequencies of the plate phenotypes changed in space and time. Morph frequencies change spatially both between depths within an area, owing to segregation of breeding females, and between areas at the same depth. Phenotypic frequencies changed temporally both within and between generations. Phenotypes favored within a generation also increased in frequency from that generation to the next. Extreme phenotypes within all morphs increased in frequency both within and between generations, and asymmetrical disruptive selection acted during at least one generation within all morphs.

Interactions between genetic variation and structure of the stickleback population appear to explain changes in the frequency of phenotypes in both space and time. Experiments to investigate the movement pattern of sticklebacks in Heisholt Lake show that the population is composed of resident individuals, which remain in a restricted area and maintain either a feeding or breeding territory, and non-residents, which move from area to area and do not breed. The phenotype of an individual influences its chances to become a resident. Females with extreme phenotypes had the greatest chance of breeding, and asymmetrical disruptive selection acted within all morphs. The phenotype of a stickleback also influences its chances of being infected with *Schistocephalus solidus*, a cestode parasite that reduces the chances of infected sticklebacks to survive and reproduce.

Spatial changes in phenotypic frequencies are caused by changes in space in the results of competition for territories. Temporal changes in phenotypic frequencies are explained by differential survival and reproduction of phenotypes as a result of differences between phenotypes in chances to obtain a territory. (From Auth. Abstr.)

76-000148 Stanley, J. G. (Maine Coop. Fish. Res. Unit, Univ. Maine, Orono 04473) PRODUCTION OF HYBRID, ANDROGENETIC, AND GYNOGENETIC GRASS CARP AND CARP. Trans. Am. Fish. Soc. 105 (1): 10-16. Jan. 1976. SFA 21(1).

Hybridization, androgenesis, and gynogenesis were studied as potential methods for creating nonreproducing populations of fish. Hybrids from crosses of female grass carp (*Ctenopharyngodon idella*) X male carp (*Cyprinus carpio*), Israeli mirror variety) died during embryonic development. Hybrids of the reciprocal cross hatched and were stocked in ponds, but most died within 3 months. Dimensions of the nuclei of erythrocytes from hybrids indicated that survivors were polyploid. Androgenetic grass carp and gynogenetic carp were both observed in this reciprocal cross. Gynogenesis occurred in 3 percent of the eggs from grass carp fertilized with UV-irradiated milt from carp. Nuclear dimensions of androgenetic and gynogenetic fish suggested a diploid karyotype. The yield of 7,862 gynogenetic grass

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carp is evidence that this method might be practical for production of monosex fish for experimentation.

76-000149 Stevenson, M. M. A COMPARATIVE CHROMOSOME STUDY IN THE PUPFISH GENUS /CYPRINODON/ (TELEOSTEI: CYPRINODONTIDAE). Ph.D. dissertation, Univ. Okla. 103p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36 (8), 1976. SFA 21(1).

The karyotypes of eleven species in the pupfish genus /Cyprinodon/ were examined with emphasis placed on those forms distributed east of the Continental Divide in the U.S. and Mexico.

From this study, the karyotypes of all species examined were identical. The diploid number was uniformly 48 and included a size graded series of 32 subterminal elements, 14 submedian elements and a single pair of median or metacentric elements. No chromosome markers, such a secondary constrictions or satellites were evident in any preparation. Also, no heteromorphic sex elements were present and spermatogonial diakinesis demonstrated 24 bivalents.

The comparative morphological and, lesser so, the behavioral data of other workers demonstrate distinct forms within /Cyprinodon/, corresponding to the nominal species populations. However, the published genetic data (both hybridization and electrophoretic) reveal less than expected divergence in those forms examined. The chromosome data presented in this report were found to commensurate with those results. Furthermore, based on the electrophoretic versus morphological data, a paradoxical situation seemingly exists with regard to selection in pupfishes. That is, those genes controlling intermediary metabolism have been held constant while morphological and behavioral determining genes were allowed to vary. It has been further postulated, from the same work, that an ancestral set of these "metabolic core" genes became established when precursor pupfish populations evolved in widely fluctuating environments. In such habitats, disruption of this coadapted segment of the genome would be strongly selected against. Therefore, assuming it is adaptive to increase linkage among coadapted genes, it is postulated that the existing karyotype in pupfishes most likely became established along with the coadapted gene sequences. Its resulting uniformity between species in /Cyprinodon/ might then be explained as increasing linkage between those genes and by subsequent selection for maintaining genetic conservancy. (From Auth. Abstr.)

76-000150 Weinstein, M. P. ELECTROPHORETIC INVESTIGATION OF THE GULF OF MEXICO AND ATLANTIC OCEAN SEATROUTS OF THE GENUS /CYNOSCION/, WITH SPECIAL REFERENCE TO THE POPULATION STRUCTURE OF THE SPOTTED SEATROUT, /CYNOSCION NEBULOSUS/. Ph. D. dissertation, Fla. State Univ. 125p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(6), 1975. SFA 21(1).

Blood serum exhibited considerable variation in banding patterns. Because direct interspecific comparisons were not possible, a phenetic analysis was employed. Eye lens and muscle patterns, however, were directly comparable. Based on the overall results, three conclusions may be drawn regarding seatrout taxonomy. First, with the exception of a single taxonomic distance ($d(jk)$) value calculated in the phenetic analysis, the relationships established by electrophoresis reflect the existing scheme. This "aberrant" value is believed to result from the small sample size and the possibility of convergence. Second, the data indicate the /Cynoscion nebulosus/ is the most divergent of the four forms, supporting previous morphological and ecological conclusions. Third, as suggested by previous studies the taxonomic status of /C. arenarius/ (Ginsburg) as a distinct species is again questioned. Electrophoretic patterns indicate that it should be regarded as a subspecific form of /C. regalis/.

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In a separate investigation the population structure of the spotted seatrout, *Cynoscion nebulosus* (Cuvier) was studied. Fishes were sampled at seven estuaries along the Gulf coast and in the Indian River area of southeastern Florida. Sera and eye lens extracts were processed by acrylamide gel electrophoresis and the banding patterns subjected to a population analysis. Each estuary sample was found to harbor a discrete population of seatrout. Differences among the populations increased with distance. The most distinct group, as expected, was found on the Atlantic side of the Florida peninsula (Indian River). Serum protein patterns provided a more sensitive method of detecting population differences than did eye lens proteins. However, both results clearly corroborate one another. (From Auth. Abstr.)

76-000151 Yardley, D.; Hubbs, C. (Dep. Zool., Clemson Univ., Clemson, SC 29631) AN ELECTROPHORETIC STUDY OF TWO SPECIES OF MOSQUITOFISH WITH NOTES ON GENETIC SUBDIVISION. *Copeia* 1976 (1): 117-120. 12 Mar. 1976. SFA 21(1).

Electrophoretic examination of *Gambusia affinis* and *G. heterochir* revealed eight monomorphic and two polymorphic loci. Identical alleles were fixed for both species at monomorphic loci with alleles shared, but with different allelic frequencies, at polymorphic loci. In contrast to other reports on genetic structuring of fish populations, this report combined with Hubbs (1971) indicated that population subdivision in *G. affinis* exists on a seasonal basis.

BEHAVIOR

76-000152 Alevizon, W. S. (Harbor Br. Found. Lab., RFDI, Box 196, Ft. Pierce, FL 33450) SPATIAL OVERLAP AND COMPETITION IN CONGENERIC SURFPERCHES (*EMBLOTOCIDAE*) OFF SANTA BARBARA, CALIFORNIA. *Copeia* 1975 (2): 352-356. 23 May 1975. SFA 21(1).

Spatial overlap was studied in two pairs of congeneric embiotocid fishes which live in and about beds of giant kelp off Santa Barbara, California. In the morphologically least divergent pair (*Embiotoca jacksoni* and *E. lateralis*), spatial interaction is minimized; the species tend to associate with different structural features of the habitat. The congeners with relatively great morphological differences (*Rhacochilus toxotes* and *R. vacca*) show substantial spatial overlap. A division of spatial resources may effectively reduce competition in the *Embiotoca* species, which exploit broadly overlapping food resources. The *Rhacochilus* species, which differ markedly in diet, apparently can overlap spatially to a much greater extent without interference.

76-000153 Allee, B. J. SPATIAL REQUIREMENTS AND BEHAVIORAL INTERACTIONS OF JUVENILE COHO SALMON (*ONCORHYNCHUS KISUTCH*) AND STEELHEAD TROUT (*SALMO GAIARDNERI*). Ph.D. dissertation, Univ. Wash. 177p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(10), 1975. SFA 21(1).

This study attempted to observe sympatric populations of coho salmon and steelhead trout in both the natural stream and in an experimental stream system. Experiments within the experimental stream system were directed at determining the effect of prior residence and size on the social behavior and population ecology of coho salmon and steelhead trout. Species specific habitat selection seemed to be a more important determiner of final population structure than prior residence. Since the majority of the density adjustments occurred

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prior to the introduction of second species it suggests that intraspecific interactions are of greater importance than interspecific ones.

No differences in the final resident population were found when either coho were larger than steelhead or when steelhead were equal in size to coho. Larger steelhead emigrated from the experimental stream system in greater numbers than smaller steelhead and greater than equal sized coho. Coho directed interspecific aggression toward steelhead irrespective of steelhead size. Steelhead did not exhibit interspecific aggression toward coho whether equal or smaller than coho.

Larger coho and steelhead of hatchery origin were significantly more numerous in the final resident population of the experimental stream system than prior resident wild coho and steelhead in a fall-winter experiment. Densities achieved by hatchery fish, when compared to wild fish in other experiments, indicated abnormally high levels which must be of poor adaptive value. Habitat segregation in the experimental stream system was evidenced by coho being more abundant than steelhead in the major pool habitat during the spring-summer experiments. During the fall, experiments indicated less selection by coho with respect to the pool habitat. Coho and steelhead were equally abundant within the stream channel habitat which was equally divided into pools and riffles. Only in the winter season when the stream channel habitat was composed of one uniform riffle did steelhead alone occupy this habitat.

In the pool habitat of the experimental stream system the best predictor of coho carrying capacity was steelhead carrying capacity, and vice versa. Therefore, neither species appeared to have a depressing effect upon the other.

Vertical stratification of habitat type during the spring and summer season indicated that coho were in the top half of the water column while steelhead were associated with the bottom.

Observation of agonistic behavior in the experimental stream channel suggests that interspecific interactions in both riffle and pool microhabitats were occurring. (From Auth. Abstr.)

76-000154 Beitinger, T. L.; Magnuson, J. J.; Neill, W. H.; Shaffer, W. R. (Radiol. Environ. Res. Div., Argonne Natl. Lab., Argonne, IL 60439) BEHAVIOURAL THERMOREGULATION AND ACTIVITY PATTERNS IN THE GREEN SUNFISH, *LEPOMIS CYANELLUS*/. Anim. Behav. 23 (1): 222-229. Feb. 1975. SFA 21(1).

Behavioural thermoregulation and locomotory activity of green sunfish were examined in a temporal temperature-gradient apparatus. Green sunfish actively avoided temperatures exceeding 30.3 C and below 26.5 C and had a median preferred temperature of 28.2 C. Temperature preference did not vary significantly during the diel period even though locomotory activity patterns were markedly crepuscular. Activity was stimulated by the change in illumination levels at dawn and dusk.

76-000155 Beitinger, T. L. INFLUENCE OF ABIOTIC AND BIOTIC FACTORS ON THE STABILITY OF BEHAVIORAL THERMOREGULATION IN FISHES, PARTICULARLY THE BLUEGILL. Ph.D. dissertation, Univ. Wis. 253p. 1974. From Diss. Abstr. Int. E Sci. Eng. 35(8), 1975. SFA 21(1).

Experiments were designed to assess the stability or sensitivity of behavioral thermoregulation by fishes under various conditions. In particular, acclimation regimes of temperature and photoperiod were studied as they influenced thermoregulatory ability and thermoselection.

Results indicated a high level of stability in thermoregulatory behavior by bluegill. With few exceptions, bluegill had a preferred

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temperature of about 31 C, circumscribed by lower and upper avoidance temperatures of approximately 29 and 33 C, respectively. Only one experiment manipulation, acclimation of bluegill to 5 C for one month, was totally disruptive to thermoregulatory performance, while five others produced variations, 0.6 to 3 C, in bluegill thermoselection. These five included 1) 30

In contrast, the majority of experimental manipulations did not influence either thermoregulatory ability or thermoselection. Day and night thermoregulatory performances were not significantly different in either bluegill or green sunfish. Imposition of unnatural photoperiods (LD 6:6:6:6 or constant light for 3 days) was not disruptive to thermoregulatory behavior of bluegill. The preferred temperatures of bluegill ranging in length from 70 to 140 mm were similar. Thirty minute exposure to 21.0 or 31.0 C did not influence subsequent thermoregulatory performance of bluegill. Fish acclimated to 21, 25, 27 and 31 C had preferred temperatures ranging from 31.0 to 31.4 C. Variations in the ratios of tank temperature increase and decrease elicited no significant changes in the thermal responses of bluegill. The reactions of bluegill to restrictions in available temperature range conformed with those expected, based on the assumption that 31 C closely approximates their final temperature preferendum. When the available temperatures were all less than 31 C, bluegill resided at the maximum available temperature. When all available temperatures exceeded 31 C, fish selected the minimum available temperature. More importantly, the opportunity to reside at potentially constant temperatures either 1 C below or 1 C above the limits of the preferred range did not override bluegill thermoregulatory behavior.

Results from growth studies indicated that bluegill respond to temperature gradient with ecological prudence. Under *ad libitum*/feeding, bluegill at 31 C grew fastest, 2.5 percent body weight per day; however, rates for fish held at 28.0 C and 25.0 C (both below the preferred temperature range) were not significantly lower. Growth rates of bluegill maintained at 34.0 C were much less than those of fish held at the three lower temperatures. These results indicate that the eurythermal bluegill has a rather broad thermal range over which growth occurs at relatively high rates. (From Auth. Abstr.)

76-000156 Beitinger, T. L.; Magnuson, J. J. (Radiol. Environ. Res. Div., Argonne Natl. Lab., Argonne, IL 60439) LOW THERMAL RESPONSIVENESS IN THE BLUEGILL, *LEPOMIS MACROCHIRUS*/. J. Fish. Res. Board Can. 33 (2): 293-295. Feb. 1976. In English with French summ. SFA 21(1).

Fifteen young bluegill, *Lepomis macrochirus*/, acclimated to 5 C at least 1 mo, died during temperature preference testing owing to apparent voluntary exposure to high temperatures. The mortality rate of 100 percent for these fish greatly exceeded the 3.8 percent rate found for 262 bluegill acclimated to temperatures ranging from 20 to 34 C, and tested in the same apparatus. Modifications in the experimental design whereby fish acclimated to 5 C were held at about 19 C for 24 h during testing, enabled all fish to survive. These bluegill selected temperatures only 2 C lower than those acclimated to summer conditions.

76-000157 Belk, M. S. (840 Mulberry St., San Antonio, TX 78212) HABITAT PARTITIONING IN TWO TROPICAL REEF FISHES, /POMACENTRUS LIVIDUS/ AND /P. ALEOFASCIATUS/. Copeia 1975 (4): 603-607. 31 Dec. 1975. SFA 21(1).

Aggressive territorial defense by /Pomacentrus lividus/ excludes /P. albofasciatus/ from a subhabitat which the latter could apparently use. The slightly larger size, more aggressive behavior and limited home range of /P. lividus/ compared with its competitor's smaller size, low aggressiveness and apparently wide ranging behavior seem to permit these congeneric fishes to coexist in the coral zone at Tumon Bay, Guam.

76-000158 Carter, T. S. THE EFFECTS OF PRIOR DEPTH EXPERIENCE, FEEDING, AGE AND LIGHT ON DEPTH PREFERENCE IN /HAPLOCHROMIS BURTONI/. Ph.D. dissertation, Mich. State Univ. 103p. 1975. Frcm Diss. Abstr. Int. B Sci. Eng. 36(3), 1975. SFA 21(1).

Shallow-raised, 12-month fish were found to appear significantly more often than deep-raised, 12-month fish, on areas that were directly associated with the substrate. These fish made fewer swim bouts and many more feeding movements than deep-raised fish. Deep-raised, 12-month fish occurred in open waters and ranged in the longest vertical column significantly more often than shallow-raised, 12-month fish. They were also in the shallow water areas more often on day one. These behaviors were suggested to be associated with the earlier experience of the fish and its response to the degree of novelty of the experimental tank situation. When fed fish were compared with unfed fish it was found that the fed fish were occupying the substrate-associated areas. They also made more feeding movements and fewer swim bouts than unfed fish. Unfed fish were in open waters and shallow water areas more often than fed fish. When 6-month fish were compared with 12-month fish, it was found that 6-month fish were in substrate-associated areas while 12-month fish occurred more often in open water and in shallow water areas. Regardless of age, all shallow-raised fish were substrate-associated while all deep-raised fish appeared significantly more often in open waters.

A second experiment examined the reaction of fish to light in a choice situation between lighted and darkened areas of the same experimental aquaria used in the first experiment. For the deep-dark testing, the deep halves of the aquaria were darkened. The shallow-dark tests had the shallow halves of the aquaria darkened. A third test, the all-lit test, was made under conditions where the entire aquarium was lit. Shallow-dark tested fish avoided the shallow-dark region, the light-dark boundary and the shallow water areas. Deep-dark tested fish showed to differences in selection of either half of the aquaria but did avoid the light-dark boundary. When shallow-dark tested fish were compared to all-lit tested fish it was found that all-lit tested fish occurred in the shallow water region much more frequently than shallow-dark tested fish. In a comparison of deep-dark tested fish with all-lit tested fish, all-lit tested fish were shown to occur in shallow water areas more frequently, while deep-dark fish occurred in the deep water areas more often. In a comparison of deep-dark tested fish with shallow-dark tested fish, no difference was found in the amount of time spent in the deep water areas. Deep-dark tested fish appeared more often in the shallow water areas. (From Auth. Abstr.)

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76-000159 Charney, P. (Dep. Ichthyol., Am. Mus. Nat. Hist., New York, NY 10024) ORAL BROODING IN THE CARDINAL FISHES /PHAEOPTYX CONKLINI/ AND /APOGON MACULATUS/ FROM THE BAHAMAS. Copeia 1976 (1): 198-200. 12 Mar. 1976. SFA 21(1).

76-000160 de Sylva, E. P. (Univ. Miami, Rosenstiel Sch. Mar. Atmcs. Sci., Miami, FL 33149) ATTACKS BY BLUEFISH (/POMATOMUS SALTATRIX/) ON HUMANS IN SOUTH FLORIDA. Copeia 1976 (1): 196-198. 12 Mar. 1976. SFA 21(1).

76-000161 Farr, J. A. III FACTORS AFFECTING SOCIAL BEHAVIOR OF THE GUPPY, /POECILIA RETICULATA/ (PISCES: POECILIIDAE), WITH EMPHASIS ON SEXUAL SELECTION. Ph. D. dissertation, Fla. State Univ. 120p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(6), 1975. SFA 21(1).

Laboratory populations of /Poecilia reticulata/, the common guppy, were observed with respect to behavioral changes with increasing population density. There was a characteristic frequency profile of number of courtship displays peculiar to each density. Aggression tended to increase with density, but was never as frequent as courtship behavior.

In a study of dominance hierarchies among males and females it was concluded that the ratio of existing to possible dominance relationships decreases with increasing population size.

Natural populations of guppies were studied in Trinidad and Tobago, and it was found that male sexual behavior and the degree of social cohesiveness vary drastically as a correlate of predation pressure. In populations with no predators or with various large characin and cichlid predators, the guppies live in dense aggregates along the edges of streams, and males exhibit a high rate of sexual behavior. Where the small cyprinodont /Rivulus hartii/ is the sole predator, sexual behavior is low and the guppies tend to disperse sparsely across the entire stream. It is believed that the organization into dense aggregates facilitates finding mates and offers protection from the large predators, and that sexual selection has increased rate of courtship behavior as a result of intermale competition for females. Because of its mode of feeding and its preference for shallow water, /Rivulus/ exerts a negative selection pressure on the above type of organization, so the guppies have lost the tendency to aggregate and they exhibit a low rate of sexual behavior.

The following model is proposed for the evolution of guppy social behavior and polymorphism in male secondary sexual coloration. It is believed that guppies evolved from a sexually monochromatic ancestor with no social cohesiveness and whose males inseminated females by gonopodial thrusting only, not by means of a courtship display. This ancestor then evolved a sexual dichromatism, facilitating efficient sex recognition, and a courtship display, allowing more efficient mating and including female choice of mates. Next, an aggregating mode of existence evolved, thus reducing the danger of not finding a mate. With a high degree of social cohesiveness, intermale competition increases, so display rate is increased by sexual selection. Those males displaying the most have the highest probability of finding receptive females. Finally, females which choose rarer males are selected for because their offspring exhibit more heterozygosity. Frequency-dependent selection results in establishment and maintenance of the male color polymorphism. This model can be tested further by observing other species of poeciliids, as all the steps hypothesized above are exhibited by some species in the family. (From Auth. Abstr.)

76-000162 Goddard, C. I.; Tait, J. S. (Dep. Biol., York Univ., Downsview, ON N3J 1P3, Canada) PREFERRED TEMPERATURES OF F(3) TO F(5) HYBRIDS OF */Salvelinus fontinalis/* X */S. namaycush/*. J. Fish. Res. Board Can. 33 (2): 197-202. Feb. 1976. In English with French summ. SFA 21(1).

Preferred temperatures were determined for samples of four generations, F(3), F(4), "F(4-5)" (F(4) X F(3)), and F(5) yearling splake (*/Salvelinus fontinalis/* X */S. namaycush/*), acclimated 4, 8, 12, 16, and 20 C. Final preferenda for the four generations were 16.3, 15.9, 15.7, and 14.8, respectively, decreasing as generation number increased. Although these values are close to the 16 C preferendum of */S. fontinalis/*, they show a trend towards the lake trout preferendum of 11.7 C. The hybrids are like */S. namaycush/* in having preferred temperatures that are virtually unaffected by changes in acclimation temperature or season.

76-000163 Goldstein, S. R. (Lakehead Univ., Thunder Bay, ON, Canada) OBSERVATIONS ON THE ESTABLISHMENT OF A STABLE COMMUNITY OF ADULT MALE AND FEMALE SIAMESE FIGHTING FISH (*/Betta splendens/*). Anim. Behav. 23 (1): 179-185. Feb. 1975. SFA 21(1).

Adult male domestic Siamese fighting fish (*/Betta splendens/*) normally engage in long, intense aggressive encounters and therefore require physical isolation from conspecifics. When adult male and female */Bettas/* were placed in a suitable environment, atypically short fights occurred resulting in a subsequent formation of a stable community. It is suggested that the establishment of a stable community is related causally to a reduction in intense forms of aggressive behaviour during initial fights for rank in the social hierarchy.

76-000164 Gruber, D.; Cahn, P. H. (Dep. Mar. Sci., Long Island Univ., East Meadow, NY 11201) LOCALIZATION OF CHEMICAL SOURCES BY BLINDED MUMMICHOGS, */Fundulus heteroclitus/*. Am. Midl. Nat. 94 (2): 500-503. Oct. 1975. SFA 21(1).

The chemoreceptive ability of blinded mummichogs, */Fundulus heteroclitus/*, was observed with respect to their capabilities to locate various chemical stimuli within a 5-min period in a flow situation. The fish were attracted when the hydrophobic amino acids, serine and cysteine, were used as the stimulants. A brine shrimp extract as well as a mummichog-mucus solution also elicited a positive response. No such responses were observed when several hydrophobic amino acids were used as the stimulants.

76-000165 Haas, R. (Dep. Biol., Calif. State Univ., Fresno 93740) BEHAVIORAL BIOLOGY OF THE ANNUAL KILLIFISH, */Nothobranchius guentheri/*. Copeia 1976 (1): 80-91. 12 Mar. 1976. SFA 21(1).

The behavior of */Nothobranchius guentheri/*, an East African annual cyprinodontid is described from aquarium and outdoor pond observations. Some aspects of biology as they probably serve adaptive function in ephemeral bodies of water are also described. */Nothobranchius guentheri/* is sexually dimorphic, reaches sexual maturity at less than 4 weeks of age and reproduces daily throughout life. Diel periodicity of both agonistic and reproductive behavior coupled with male linear hierarchies, absence of territories and mating promiscuity results in enhancement of opportunity for receptive females to come into contact with males. Initial contact between the sexes is largely dependent on positive orientation of the cryptically colored females towards the visually obvious males. Reproductive behavior has been reduced to those movements necessary for

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fertilization of the eggs which are deposited below the substrate surface. These features of the species' biology and behavior in combination with drought resistance of the eggs and embryological diapause serve to maximize reproductive success in a temporally and spatially unreliable environment.

76-000166 Hobson, E. S. (NMFS, Tiburon Lab., Tiburon, CA 94920) THE ROCK WRASSE, /*HALICHOERES SEMICINCTUS*/ AS A CLEANER FISH. Calif. Fish Game 62 (1): 73-78. Jan. 1976. SFA 21(1).

What may have been one individual rock wrasse, /*Halichoeres semicinctus*/, was observed over 10 months cleaning other fishes at Santa Catalina Island. Cleaning is an insignificant activity for rock wrasse in general, but was a major activity of the individual involved in each of these observations. Cleaning activity of the rock wrasse is similar in most respects to that of its relative, the senorita, /*Oxyjulis californica*/.

76-000167 Holzberg, S.; Schroder, J. H. (Ist. Biol. Ges. Strahlen- und Umweltforschung, Neuherberg, bei Munchen, Germany) THE INHERITANCE OF AGGRESSIVENESS IN THE CONVICT CICHLID FISH, /*CICHLASOMA NIGROFASCIATUM*/ (PISCES: CICHLIDAE). Anim. Behav. 23 (3): 625-631. Aug. 1975. SFA 21(1).

Intraspecific comparisons in aggression were made between X-irradiated (2 x 500 R) ancestors and untreated control animals. Bites delivered to sub-adult conspecifics were counted to measure aggressiveness. When compared with corresponding controls, a significant reduction in male aggressiveness was found in the post-irradiation F(1) generation. A greater variation in bites delivered occurred among the F(2) post-irradiation generations than among the control equivalents. Three distinct back-cross generations were obtained as follows: a single F(1) female from the irradiated line was mated to (a) her high aggressive (I-A) and (b) her low aggressive (I-NA) F(2) son; a F(1) control female was mated to her low aggressive F(2) son. In the back-cross generations, both I-A and C-NA males were more aggressive than I-NA males. No differences were found between I-A and C-NA back-cross males. The findings are discussed in terms of a two-factor model based on Mendelian laws.

76-000168 Hopkins, C. D. PATTERNS OF ELECTRICAL COMMUNICATION AMONG GYMNOTID FISH. Ph.D. dissertation, The Rockefeller Univ. 200p. 1972. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. SFA 21(1).

This paper presents the results of a twelve-month field study of the behavior and ecology of gymnotid fish from the Rupununi District of Guyana, South America, and from Trinidad, W.I. There are 13 species of gymnotids in the Rupununi District, of which six to eight species occur frequently in the main study area in Moco-moco Creek. All species produce electrical discharges which are presumably used for object location and for electrical communication.

Gymnotids are active at night and inactive during the day. Some species tend to specialize on the types of daytime hiding places selected, while others generalize. The breeding season of most gymnotids starts with a migration into a quiet, flooded swamp, immediately after the first flood at the beginning of the rainy season. Inspection of gonadal condition and plots of the growth rates of gymnotid larvae show that most species delay breeding until the onset of the rains.

Both /*Eigenmannia*/ and /*Sternopygus*/ produce electric discharges that differ from all other species of gymnotids from Moco-moco Creek. Among the fish with tone discharges, /*Sternopygus*/ produces the one with lowest frequency (50 to 150 Hz) and /*Eigenmannia*/ produces the

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one with next lowest (250 to 600 Hz). Each species produces an appropriate species-specific response when presented with an electric sine wave stimulus of the appropriate frequency.

/Sternopygus/ exhibits a sexual difference in the resting frequency of its normal discharge. This frequency difference has communicative significance. Males, showing site-attachment during the breeding season, respond to playback of sine waves of frequencies within the female range with transient frequency increases and discharge cessations. Males do not respond to playback of sine waves of frequencies corresponding to the other males nor to other species of tone fish from the Rupununi. Further evidence indicates that variations in the discharge of males may function in the courtship of this species.

The agonistic behavior of /Eigenmannia/ was observed in aquaria in the field, and was described in terms of the component actions, both electrical and motor. (Frcm Auth. Abstr.)

76-000169 Losey, G. S., Jr. (Dep. Zool., Univ. Hawaii, Honolulu 96822) /MEIACANTHUS ATRODORSALIS/: FIELD EVIDENCE OF PREDATION PROTECTION. Copeia 1975 (3): 574-576. 5 Aug. 1975. SFA 21(1).

76-000170 MacCrimmon, H. R.; Hawkins, C. M. (Dep. Zool., Coll. Biol. Sci., Univ. Guelph, Guelph, ON N1G 2W1, Canada) ROLE OF REARING EXPERIENCE IN GRAVEL SUBSTRATE SELECTION BY JUVENILE RAINBOW TROUT, /SALMO GAIEDNERI/. J. Fish. Res. Board Can. 33 (2): 282-284. Feb. 1976. In English with French summ. SFA 21(1).

Laboratory studies on hatchery-reared wild juvenile rainbow trout (/Salmo gairdneri/) in an experimental raceway show no significant selection (P less than 0.05) of test gravel substrates under either nonflowing or flowing (0.03 m/s) conditions regardless of rearing experience. There is no statistical evidence that hatchery conditioning of rainbow trout for gravel substrate selection is likely to be a feasible undertaking.

76-000171 Martin, R. G. THE SOCIAL BEHAVIOR OF THE MOSQUITOFISH, /GAMBUSIA AFFINIS HOLBROOK/ (GIRARD), IN THE FIELD AND LABORATORY. Ph.D. dissertation, Fla. State Univ. 174p. 1975. Frcm Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

Observations of social behavior in the mosquitofish, /Gambusia affinis holbrooki/, were conducted for two years in a natural spring-fed pool using 16-mm photography, and in the laboratory at various densities. Population density in nature was highest in areas of dense vegetation and lowest in open water areas. Mean sexual activity in open water areas was lowest in winter and late summer, highest in the spring. The rate of aggressive activity in nature was very low compared to sexual activity. Aggressive interactions were mostly mild-male-male threats. Social behavior and population structure in nature were related seasonally to environmental factors including water temperature, dissolved oxygen, amount of vegetation, and the presence of competitors of mosquitofish. In the laboratory, the rate of sexual activity was approximately the same as in the field at densities of one pair, two pair, five pair, and ten pair in 14 liter aquaria. Conversely, aggressive activity in aquaria was greater than in the field and increased steadily with density. Some components of sexual behavior typical of the field were not observed in the laboratory, and aggressive interactions were much more intense in the laboratory. Field and laboratory observations both underscored the importance of female response, and by inference, female choice for successful reproductive activity. Melanistic males were rare in nature, occurring mostly in areas with clear, spring-fed waters and some piscine

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predators. In the laboratory, certain predators ate melanistic males, but did not appear to prefer them over normal males. At high laboratory densities, especially ten pair, melanistic males were extremely aggressive to normal males and had a clear dominance advantage over normals. Whether or not melanistic males also had a mating advantage was unclear. If it can be subsequently shown that they do, a case for Darwinian sexual selection may be drawn.

76-000172 Martin, R. G. (Sch. Forest Resour. Conserv., Univ. Fla., Gainesville 32611) SEXUAL AND AGGRESSIVE BEHAVIOR, DENSITY AND SOCIAL STRUCTURE IN A NATURAL POPULATION OF MOSQUITOFISH, /GAMBUSIA AFFINIS HOLBROOKI/. Copeia 1975 (3): 445-454. 5 Aug. 1975.

A comparison of sexual and aggressive behavior of the mosquitofish showed much variation between the laboratory and the field. Analysis of 16 mm films taken underwater /in situ/ revealed that sexual behavior frequently included the category "chase," a behavioral unit almost never seen in laboratory aquaria. The films also provided three examples of copulation, in which female "tilting" was observed. Aggression, infrequent and mild in the field, was frequent and more intense in the laboratory. Seasonal changes in population structure and behavior were analyzed; for example, winter grouping behavior dissolved at springtime; sexual activity peaked during the spring. A sex ratio of 1 female:5 males was apparently optimal for sexual activity. Two distinct population "systems" operated in the field. Mosquitofish were either over open water or concealed in vegetation along the shorelines of the study area. Since filming was possible only in the open water area, the population system concealed in vegetation was not adequately analyzed. Thus the comparison of density-dependent social behavior in the laboratory and field was valid only from the viewpoint of the open water system as representative of the field.

76-000173 Mason, J. C. (Fish. Mar. Serv., Pacific Biol. Stn., Nanaimo, BC V9B 5K6, Canada) SOME FEATURES OF COHO SALMON, /ONCORHYNCHUS KISUTCH/, FRY EMERGING FROM SIMULATED REDDS AND CONCURRENT CHANGES IN PHOTOBEHAVIOR. NOAA Fish. Bull. 74 (1): 167-175. Jan. 1976. SFA 21(1).

The emergence of sibling coho fry from simulated redds lasted 20-23 days during which 97-98 percent of the fry emerged. Average size of emerging fry increased with time but the largest fry emerged during the peak of emergence. No clear preference was shown for nocturnal or daylight emergence but the latter increased with time. Fry showed a positive current response, 69-82 percent moving upstream following emergence. Most fry emerged when yolk reserve was reduced to less than 10 percent of total dry weight. Later-emerging fry did not have lower yolk reserves, but fry moving downstream had slightly more yolk reserve than did fry moving upstream. Fry which were captured shortly after emergence had fed actively but had not yet filled their air bladders. Chironomids composed 70 percent of their diet.

Photoresponse of sibling fry denied the redd experience was studied in light-dark choice boxes with reference to the timing of emergence of fry from the simulated redds. The pronounced photonegative behavior of the denied fry was suddenly lessened at time of emergence but remained photonegative. Weakening of the negative photoreponse was not the outcome of starvation or recent light experience, and was not modified by repeated testing. Retention of the photonegative response is referred to hiding behavior and use of the gravel bed as a refuge.

76-000174 Miles, P. S. AGNOSTIC BEHAVIOR OF SOME GOBID FISHES FROM THE GULF OF CALIFORNIA. Ph.D. dissertation, Univ. Ariz. 175p. 1975. From Diss. Abstr. Int. E Sci. Eng. 36(2), 1975. SFA 21(1).

Agnostic behaviors in the gobiid fishes studies consisted of appetitive locomotor activity, contacts, and threat displays. Courtship behaviors were also observed in three species. All behaviors were defined in terms of functional units meeting ethological standards for comparative study. A trellis diagram which illustrates comparative relationships among the species was constructed with the agnostic units. (From Auth. Abstr.)

76-000175 Nelson, G. G. (870 4th Ave., Salt Lake City, UT 84103) ANATOMY OF THE MALE UROGENITAL ORGANS OF /GOODEA ATRIPINNIS/ AND /CHARACODON LATERALIS/ (ATHERINIFORMES: CYPRINODONTOLDEI), AND /G. ATRIPINNIS/ COURTSHIP. Copeia 1975 (3): 475-482. 5 Aug. 1975. SFA 21(1).

Goodeid males do not have a gonopodium as do other viviparous cyprinodontoids. To elucidate mode of insemination in goodeids, the anatomy of male urogenital structures of two species, /Goodea atripinnis/ and /Characodon lateralis/, and reproductive behavior of /G. atripinnis/ are described. The urogenital organ consists of a muscular mass perforated by the vas deferens and urinary canal. In reproduction the organ produces a spurt of spermatophores. Immobility of the organ requires considerable pair coordination and synchronization during insemination. Courtship in the female is restricted to receptive and non-receptive behavior. Very close contact is maintained between the breeding pair during copulation.

76-000176 Otto, R. G.; Kitchel, M. A.; Rice, J. O. (Chesapeake Bay Inst., Johns Hopkins Univ., Baltimore, MD 21218) LETHAL AND PREFERRED TEMPERATURES OF THE ALEWIFE (/ALOSA PSEUDOHARENGUS/) IN LAKE MICHIGAN. Trans. Am. Fish. Soc. 105 (1): 96-106. Jan. 1976. SFA 21(1).

The temperature tolerance and temperature preference of mature and young-of-year alewives from Lake Michigan were studied in the laboratory. Critical thermal maxima and incipient upper lethal temperatures increase with acclimation temperature for both mature and young-of-year fish. Critical thermal maxima at equivalent acclimation temperatures are unaffected by age of the fish. Incipient upper lethal limits for young-of-year fish exceed those for mature fish by 3 C to 6 C. The ultimate lower lethal temperature for mature alewives appears to exceed 3 C. Loss of heat tolerance following a 10 C decrease in temperature occurs at approximately one-half the rate of gain of heat tolerance following a comparable temperature increase.

Preferred temperatures for young-of-year alewives were consistently higher than those of mature fish. Seasonal factors other than lake temperature appear to be of considerable importance in determining preferred temperatures. The results are discussed in terms of potential effects of the heated plume from a nuclear generating station and available field data.

76-000177 Parker, N. C.; Simco, B. A. (Dep. Wildl. Fish. Sci., Texas A&M Univ., College Station 77843) ACTIVITY PATTERNS, FEEDING AND BEHAVIOR OF THE PIRATEPERCH, /APHREDODERUS SAYANUS/. Copeia 1975 (3): 572-574. 5 Aug. 1975. SFA 21(1).

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76-000178 Randolph, K. N. THE DAILY ROUTINE OF CHANNEL CATFISH, /ICTALURUS PUNCTATUS/, IN CULTURE PONDS. Ph.D. dissertation, Univ. Okla. 67p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(4), 1975. SFA 21(1).

Three distinct behavior patterns were recognized in the daily routine of channel catfish in culture ponds: (1) occupancy of a home area, (2) daily trip to the feeding station, and (3) feeding. When the fish were not in home areas they were going to or from the feeding station by specific routes or swimways. Home areas were relocated from deep to shallow areas or from shallow to deep areas depending on the temperature conditions. In the spring and fall, home areas were in shallows but during summer and winter they were in deeper parts of the pond. Likewise, fish seasonally adjusted their swimways. Perimeter swimways were used during spring, but were discontinued for direct swimways when water temperatures reached 18 C. Throughout most of March to October, marked fish made a daily trip to the feeding station. In the spring, fish did not utilize demand feeders until temperatures were 12 C. Fish stopped demand feeding in the fall at approximately 15 C, following an abrupt decrease in temperature of approximately 11 degrees (C). In the spring, intermittent feeding appeared to be primarily temperature related. Fish shifted feeding periods from midday to evening as the feeding season progressed. The shift is explained by the fish becoming acclimated to increasing temperature and selecting for warmer temperature. During summer, low oxygen concentration often caused fish to adjust or miss their daily feeding period. Feeding was reduced at oxygen values below 5 mg/l, but small fish occasionally fed at values as low as 2 mg/l since they were acclimated to feeding at low values. Contacts between different sizes of fish at the feeding station established a feeding hierarchy and subdominant fish often waited to feed. Large fish were dominant in feeding and sex did not appear to be a factor in determining feeding status. Length of waiting to feed ranged from 0 to 3 hr for the larger fish and from 0 to 12 hr for the smaller fish. (From Auth. Abstr.)

76-000179 Russock, H. I. SOCIAL BOND FORMATION IN THE CICHLID FISH /TILAPIA MOSSAMBICA/. Ph.D. dissertation, W. Va. Univ. 138p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(7), 1976. SFA 21(1).

It was concluded that /T. mossambica/ fry hatch with an "initial perceptual schema" which predisposes them to respond to certain characteristics of the broody mother. However, when the fry are naive they will /initially/ respond to almost any object regardless of whether or not the object fits their schema. If the object they initially respond to does /not/ fit their schema (i.e., red rectangle), experience with the inadequate object (or with objects that better fit their schema) will cause them to stop responding to the inadequate object in the future. On the other hand, if the initial maternal object closely matches their schema (i.e., black pit model), the fry will respond to it regardless of previous experience. Finally, the fry's "initial perceptual schema" undergoes a developmental deterioration which explains why the fry in the present study exhibited a significant decrease in positive responses to maternal models by day 16 regardless of their previous experience. The deterioration also ensures that normal fry will avoid mouth-size holes after they have left their mother, a phenomenon which is highly adaptive.

The second section of the study dealt with the effects of social bond formation on the sexual preferences of adult fish. It was found that all groups of adult fish preferred to court and 'stay near' conspecifics, regardless of gender or previous social experience. It was concluded that recognition of, and preference for, conspecifics is strongly 'innate' in /T. mossambica/ and that neither imprinting nor taming is needed for this innate preference to appear. It was

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considered likely that recognition of conspecifics during courtship is ensured by innately recognized courtship colors, markings, and/or movements. (From Auth. Abstr.)

76-000180 Salli, A. J. THE DISTRIBUTION AND BEHAVIOR OF YOUNG-OF-THE-YEAR TROUT IN THE BRULE RIVER OF NORTHWESTERN WISCONSIN. Ph.D. dissertation, Univ. Wis. 299p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. SFA 21(1).

A study was conducted of the distribution and behavior of young-of-the-year brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*) in the Brule River of northwestern Wisconsin for a number of years. A portable observation chamber was designed and used in the behavioral studies. Extensive observations of the distribution revealed a distinct segregation of the three species, due to selection of microhabitats by the fry and different times of emergence. The microhabitats occupied by each are different although spatially not far apart. Evidence suggests that the microhabitats occupied are the result of volitional residence rather than interactive segregation due to intense interspecific competition.

The microhabitat occupied by brook fry is the shallow littoral habitat, where they maintain stations near mid-water 1-15 cm deep, in currents 0-14 cm/sec., over a variable substrate.

The microhabitat occupied by brown fry is a firm, clean bottom habitat, where they maintain bottom stations in water 15-40 cm deep, with current velocities 15-30 cm/sec. above them. The microhabitat is characterized by firm, clean substrate and presence of aquatic plants.

The microhabitat occupied by rainbow fry upon emergence in June is the shallow littoral habitat, where they maintain stations near midwater in water 1-15 cm deep, in currents 5-15 cm/sec., over a variable substrate.

Members of each species showed territoriality or localized dominance around some point in the environment to which they formed site-attachment. Territories are feeding territories and of a diffuse station type. Analysis of the activity of the trout, from five-minute counts of all behavior observed, indicated that feeding passes made up almost 94 percent, agonistic passes about 3 percent, and wandering activity approximately 3 percent of all activity observed.

Feeding behavior was intensively investigated, including types, distances, and frequencies of feeding passes, in addition to size and shape of the mean feeding range. Agonistic behavior was intensively investigated, including types of agonistic passes, distances and frequencies of attack passes, in addition to size and shape of the territory. Although the frequency of aggression is low, it appears that aggression and territoriality play a significant role in the lives of these young trout. Results indicate that the distribution and microhabitat occupied has an influence on the behavior of the young trout. (From Auth. Abstr.)

76-000181 Scherer, E. (Fish. Mar. Serv., Freshwater Inst., Winnipeg, MB R3T 2N6, Canada) OVERHEAD-LIGHT INTENSITY AND VERTICAL POSITIONING OF THE WALLEYE, *STIZOSTEDION VITREUM VITREUM*. J. Fish. Res. Board Can. 33 (2): 289-292. Feb. 1976. In English with French summ. SFA 21(1).

Laboratory experiments were devised to test field observations and eye-histological indications that light may strongly influence the spatial distribution of the walleye (*Stizostedion vitreum vitreum*). In 48 tests, fish were exposed to sequences of three different light intensities in discrete logarithmic steps, viz. 200, 20, 2lx, in that and in reversed order. The result was an inverse relation between light intensity and height of fish position in the test tank, with highly significant differences between positions at different

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intensities. This response may provide the basis for a useful technique to detect sublethal levels of environmental toxicants.

76-000182 Scholz, A. T.; Horrall, R. M.; Cooper, J. C.; Hasler, A. D.; Madison, D. M. (Univ. Wis., Lab. Limnol. Madiscn) ARTIFICIAL IMPRINTING OF SALMON AND TROUT IN LAKE MICHIGAN. Wis. Dep. Nat. Resour., Fish Manage. Rep. No. 80. 45p. 1975. SFA 21(1).

In studies conducted in Lake Michigan from 1971 to 1974, coho salmon and steelhead trout which were exposed to a synthetic chemical (morpholine) while undergoing the smolting process, returned during the spawning migration to a stream which had been scented with morpholine. Behavioral and physiological experiments with homing adult fish showed that morpholine-exposed fish can detect and discriminate morpholine while control fish which had not been exposed did not react to the chemical. A second chemical, phenethyl alcohol, was also used for imprinting and similar results were obtained.

These results document that coho salmon and steelhead trout learn and utilize artificial chemical cues for homestream selection. They indicate that it is possible to manipulate the migration of some species of salmonids by artificially imprinting smolts to synthetic chemicals. Fish do not have to be imprinted to a natural stream system but rather can be imprinted at a fish hatchery and later decoyed or attracted to specific areas. This approach offers greater management flexibility and may also be preferable for economic and biological reasons. These studies have direct application for the management of salmon stocks in Lake Michigan and other parts of the world.

A detailed summary of imprinting techniques is provided which includes information about equipment, selection of chemicals, critical or sensitive exposure periods and stocking procedures. Sample calculations are provided in an appendix.

76-000183 Steele, R. G. SPECIES RECOGNITION AND REPRODUCTIVE ISOLATION IN TWO SPECIES OF SUNFISH (CENTRARCHIDAE). Ph.D. dissertation, Univ. Western Ontario 1974. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. [Order microfiche copy from the National Library of Canada at Ottawa.] SFA 21(1).

In the Middle Branch of the Thames River, 20 km east of London, Ontario, two species of sunfish are found: the pumpkinseed, *Lepomis gibbosus* L., and the northern longear, *L. megalotis* peltastes/ Cope. Male sunfish intermediate in some aspects of morphology and nesting behavior and hence presumed to be hybrids, are present in relatively small numbers in the same area. Breeding season and habitat overlap in these two species suggesting that conspecific mate selection may be important in reducing the incidence of hybridization between the species. Mate selection could not be directly tested, as mate selection experiments depend on an adequate supply of ripe fish and these were available only in limited quantities. Consequently choice experiments were conducted in which the behaviour of fish (both sexes of both species) of a variety of ripenesses was recorded in response to two fish of the other sex.

Results from two types of choice apparatus were similar. However, several simplifying assumptions were made in analysing the data from one choice apparatus. The tentative explanation offered for the results obtained with this analysis is that longear females, presented with nesting-sized longear males and either nesting-sized pumpkinseed or hybrid males (both types larger than longear males) directed more activity toward conspecifics. Pumpkinseed females offered a choice of nesting-sized longear and pumpkinseed males directed more activity toward conspecifics. Small pumpkinseed females offered large hybrid males and smaller longear males chose the latter. Male pumpkinseeds chose conspecific females but male longears either did not choose or

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chose conspecifics when both were presented with unequal-sized pumpkinseed and longear females.

The clear conspecific choice shown by some of the fish in these experiments indicates their ability to distinguish between the two types of fish with which they were presented. The clear conspecific choice by both longear females and pumpkinseed males would therefore suggest hybridization is unlikely between them. However, reproductive isolation between longear males and small pumpkinseed females seems less complete.

The role of hybrid sterility in reducing interbreeding between the species was also assessed by artificially fertilizing the eggs from females of the two species with milt from the three types of males. The hybrid cross produced a lower percent hatch of eggs than the intraspecific cross for eggs from both species of females. (From Auth. Abstr.)

76-000184 Stout, J. F. (Biol. Dep., Andrews Univ., Berrien Springs, MI 49104) SOUND COMMUNICATION DURING THE REPRODUCTIVE BEHAVIOR OF /NOTROPIS ANALOSTANUS/ (PISCES: CYPRINIDAE). Am. Midl. Nat. 94 (2): 296-325. Oct. 1975. SFA 21(1).

Field and laboratory observations were made on the reproductive behavior, ecology and sounds produced by males of /Notropis analostanus/ during reproductive behavior. Based on these observations, experiments were performed on sound communication during the reproductive behavior of this species.

Reproductive activities began in middle to late May when the males set up territories around a suitable egg site. The males defended these territories by chasing and fighting behavior which included the lateral threat display. During this aggressive behavior, "single knocks" and "rapid series of knocks" were produced. Courtship behavior began when a female approached the territory and the male swam out to her. If the female did not swim away the male swam in circles around her and then swam to the egg site where it would perform "solo-spawning" motions. Spawning was accomplished when the female followed the male to the egg site and assumed a spawning position with the male in a dorsolateral position to her. During the courtship behavior the male produced "single knocks" and "purrs."

The functions of sounds produced by male /Notropis analostanus/ during reproductive behavior were studied by playing back these sounds under experimental conditions designed to clarify their functions as communicative signals.

The following conclusions were reached:

1. The "single knocks" were not effective in influencing aggressive behavior of males nor did they promote courtship.
2. The "rapid series of knocks" stimulated aggressive behavior by a dominant male and inhibited the entry of a submissive male into the territory.
3. The "rapid series of knocks" inhibited the courtship behavior of the male and reduced cooperation by the female during courtship.
4. The "purrs" increased the courtship behavior of the male and promoted the cooperation of the female during courtship.

76-000185 Westby, G. W. M. (Lab. Physiol. Nerv., Cent. Natl. Rech. Sci., Groupe Lab. C.N.R.S., 91190, Gif sur Yvette, France) COMPARATIVE STUDIES OF THE AGGRESSIVE BEHAVIOUR OF TWO GYMNOTID ELECTRIC FISH (/GYMNOTUS CARAPO/ AND /HYPOPOMUS ARTEDI/). Anim. Behav. 23 (1): 192-213. Feb. 1975. SFA 21(1).

Electrical and motor behaviour was studied during aggressive interactions in two species of electric fish (/Gymnotus carapo/ and /Hypopomus artedi/). Paired comparison methods were used to obtain the data, and analysis of the results was undertaken at three different

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levels: (1) The repertoire of behaviour (motor and electrical); (2) The changes in relative frequency of components with increasing exposure to conspecifics; (3) Sequential analysis of patterns of behaviour occurring both within and between individuals. The results of the three analyses showed: (1) A great similarity in repertoire although a much higher rate of interaction for *Gymnotus*/. The relative importance of the 'off' and 'burst' signals was reversed for the two species. A prolonged orientation component in *Hypopomus*/ was found to be related to the occurrence of discharge synchrony. (2) Habituation of intense components in favour of electrical signalling in both species. (3) Important differences in both the length and structure of sequences.

76-000186 Westby, G. W. M. (Lab. Physiol. Nerv., Cent. Natl. Rech. Sci., Groupe Lab. C.N.R.S., 91190, Gif sur Yvette, France) FURTHER ANALYSIS OF THE INDIVIDUAL DISCHARGE CHARACTERISTICS PREDICTING SOCIAL DOMINANCE IN THE ELECTRIC FISH, *GYMNOTUS CARAPO*/. Anim. Behav. 23 (2): 249-260. May 1975. SFA 21(1).

The electric organ discharge (EOD) behaviour of *Gymnotus carapo*/ was analysed in isolated fish with no previous experimental experience. All animals were then allowed social interaction (4 hr total), and were finally retested in isolation. Each of the two individual testing sessions consisted of four trials per fish, during which frequency histograms of the EOD intervals were accumulated. The results showed that the histograms were invariably multi-modal, and the reasons for this were examined. They were then subjected to a computer-aided statistical analysis, and various features were shown to be related to the dominance status of the fish determined in the second part of the study. A subsequent experiment performed 6 months later demonstrated sequential frequency 'shifts' in resting isolated *Gymnotus*/. These shifts are discussed in terms of the interval histogram results, and it is suggested that they represent a type of social advertisement. Finally, a hypothetical physiological mechanism is proposed to account for the observed EOD distributions.

LIFE HISTORIES-GENERAL WORKS

76-000187 Aceituno, M. E.; Vanicek, C. D. (U.S. ELM, 7663 Federal Bldg., Los Angeles, CA 90012) LIFE HISTORY STUDIES OF THE SACRAMENTO PERCH, *ARCHOPLITES INTERRUPTUS*/ (GIRARD), IN CALIFORNIA. Calif. Fish Game 62 (1): 5-20. Jan. 1976. SFA 21(1).

Aspects of the life history of the Sacramento perch from Lake Greenhaven and Lake Almanor are described. Spawning occurred in May and possibly early June in Lake Greenhaven, and in late May and June in Lake Almanor. Seven age groups, 0 through VI, were present in each population. Females outnumbered males, particularly at older ages, and grew slightly faster than males in both populations. Greenhaven fish grew faster than Almanor fish. Length-weight relationships and condition factors of the two populations were similar. Food habits analysis of Lake Greenhaven fish indicated that the major food items were chironomid larvae and pupae and zooplankton. Life history characteristics from these populations are compared with those reported for other Sacramento perch populations.

76-000188 Brothers, E. B. THE COMPARATIVE ECOLOGY AND BEHAVIOR OF THREE SYMPATRIC CALIFORNIA GOBIES. Ph.D. dissertation, Univ. Calif. (San Diego) 387p. 1975. From Diss. Abstr. Int. E Sci. Eng. 36(7), 1976. SFA 21(1).

Clevelandia ios, *Ilypnus gilberti* and *Quietula y-cauda* are closely related, ecologically similar gobies which co-occur in intertidal and shallow subtidal waters of bays, estuaries and lagoons of California. Laboratory and field studies of these fish were designed to answer two basic questions. First, what is the degree of ecological differentiation (morphological and behavioral) between the species? Second, how are the differences between their respective ecological niches reflected in their life histories and population structures and dynamics? Morphological examination of the gobies reveals significant differences in several ecologically important characters, including coloration, gas bladder size, mouth size, gill raker spacing, and epidermal specializations associated with burrowing behavior. Although the species are very closely associated spatially, distinct habitat preferences have been demonstrated by collection and observation in the field and by laboratory substrate selection experiments. There are many interspecific differences relating to maximum adult size, age at first maturity, growth rate, age-specific mortality patterns, reproductive effort, population density and stability, recruitment, dietary specialization, and parasite loads. There is intraspecific geographic variation in growth rate, mortality and fecundity. Moderate dietary separation appears to be largely a product of differential availability due to microhabitat differences and some behavioral and morphological adaptations for selective feeding. Differences in social behavior, morphology (including sexual dimorphism) and life history are interpreted in relation to the food and space utilization characteristics of each species. In the process of adapting to different microhabitats, each species has acquired a unique set of structural, behavioral, and life-history features. (From Auth. Abstr.)

76-000189 Chew, R. L. (Game Freshwater Fish Comm., Tallahassee, FL 32304) EARLY LIFE HISTORY OF THE FLORIDA LARGEMOUTH BASS. Fla. Game Freshwater Fish Comm. Fish Bull. No. 7. 76p. 1974. SFA 21(1).

The early life history of the Florida largemouth bass was investigated in two environmentally different lakes. The zooplankton community in both lakes consisted of copepods and cladocerans and fluctuated considerably. There appeared to be an abundant invertebrate food supply for larval and juvenile bass in both lakes. Peak bass spawning occurred in March at water temperatures of 60-65°F. Fish were 148 mm (FL) at age 1 and 240 mm at age 2 in one lake, and 188 mm at age 1 in the other lake. "K" values varied with size of fish and were highest during the summer. Bass 13-30 mm (FL) fed almost exclusively on zooplankton. Bass 31-75 mm fed predominantly on small insects and fish, and bass 775 mm fed on fish and decapods. Sex ratios were 1:1. (RS)

76-000190 Chittenden, M. E., Jr. (Dep. Wildl. Fish. Sci., Texas A&M Univ., College Station 77840) WEIGHT LOSS, MORTALITY, FEEDING, AND DURATION OF RESIDENCE OF ADULT AMERICAN SHAD, *ALCSA SAPIDISSIMA*, IN FRESH WATER. NOAA Fish. Bull. 74 (1): 151-157. Jan. 1976. SFA 21(1).

Linear regression equations are given for each sex for the regressions of total weight, somatic weight, and gonad weight on length prior to spawning, and for total weight on length after prolonged stay in fresh water.

Most shad began to return seaward by late June and probably had spent a maximum of about 2 mo in fresh water. Many fish, however,

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remained near the spawning grounds well into summer; and many died near the spawning grounds, probably from starvation. Opportunistic feeding occurred on "planktonic" items, but adult shad do not regularly obtain energy sufficient to maintain their weight in fresh water. Weight loss was related to sex and increased with increasing size. Mean length males and females averaged 45 and 57 percent total weight loss, respectively. Daily somatic weight loss was at least 5.75 g for males of average size and 12.47 g for females.

76-000191 Hackney, P. A. ECOLOGY OF THE BURBOT (/LOTA LOTA/) WITH SPECIAL REFERENCE TO ITS ROLE IN THE LAKE OPEONGO FISH COMMUNITY. Ph.D. Dissertation, Univ. Toronto 1973. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. [To obtain microfiche copy order from the National Library of Canada at Ottawa.] SFA 21(1).

I undertook a study of the burbot populations in Lake Opeongo, 5850 ha and Lake Lavielle, 2406 ha, both in Algonquin Provincial Park, Ontario. A comparison of material collected in 1938 and 1941 with data from the 1969-72 period revealed that burbot currently grow faster, live longer, and achieve much larger sizes than during the earlier era. This appears to be related to the introduction of cisco in 1948 as does also the highly variable recruitment evident since the late 1950's. Burbot in Lake Lavielle grow more slowly, do not live long or achieve large sizes. The natural mortality rate for adult burbot in Lake Opeongo appears to have decreased significantly following introduction of cisco. Irregularity of recruitment does not permit calculation of a mortality coefficient for material gathered during 1969-72 but data collected in 1941 yielded M of 0.30 with $r(M)$, age = 0.96.

Sexual maturity begins by at least age III. Spawning probably occurs about mid-February although spawning sites were not discovered. Young were not found in Lake Opeongo during 1969-72; however, in Lake Lavielle they inhabited shallow areas, hiding under rocks during daylight hours. An estimate of 2837 burbot was made from tag and recapture data for the South Arm of Lake Opeongo. A standing biomass estimate of 1.25 kg/ha for the South Arm was estimated utilizing the Schumacher-Eschmeyer multiple census formula. Burbot moved as much as 4.8 km from the site of marking and up to 0.2 km/day in Lake Opeongo. There was a strong tendency for burbot of similar size to be found together. Adult burbot typically selected thermal strata of 10 to 12 C. They avoided areas of soft, silty substrate. Catch per unit of effort was much lower in summer than during periods of cooler water temperature. Burbot are nocturnal feeders and fishes upon which they prey are typically quiescent at this time. They evidently locate their food through a combination of smell, touch, and hearing.

Food habits changed considerably following introduction of the cisco in 1948, the species consumed being in different proportions although the total amounts ingested were similar.

A number of studies have suggested that competition between burbot and lake trout for food may be relatively intense. Simulation results predicted that lake trout yield is currently near maximum but that it could be increased by substantial exploitation of the burbot population.

The introduction of cisco to Lake Opeongo had far reaching effects, resulting in modifications of life history patterns in many of the other fish species. (From Auth. Abstr.)

76-000192 Hauer, F. R. (Dep. Fish. Wildl., Mich. State Univ., East Lansing 48823) COMPARISON OF PREOPERATIONAL AND OPERATIONAL ABUNDANCE, AGE, LENGTH-WEIGHT RELATIONSHIPS, AND FOOD HABITS OF YELLOW PERCH, */PERCA FLAVESCENS/* (MITCHILL), IN LAKE MICHIGAN AND THE LUDINGTON PUMPED STORAGE RESERVOIR. MS thesis, Mich. State Univ., East Lansing vii + 75p. 1975. SFA 21(1).

This study was undertaken to determine what effects the operation of a pumped storage hydroelectric plant would have on yellow perch populations, */Perca flavescens/* (Mitchill) in the adjacent waters of Lake Michigan.

Yellow perch were collected from six locations in Lake Michigan with variable mesh gill nets several times each month from April through November. Data were collected during one preoperational year (1972) and two operational years (1973 and 1974). All comparisons were made on a seasonal basis. Yellow perch were also collected from three stations in the reservoir from April through November, 1973 and 1974.

Morphometric data, scale samples, and stomach samples were taken from a representative sample of yellow perch at each collection in both Lake Michigan and the reservoir.

Several changes in abundance occurred over the three-year period in Lake Michigan. During the spring there was a decrease in catch per unit effort at the shallow stations adjacent to the power plant and an increase at the control station. Abundance in the reservoir was significantly lower than in Lake Michigan. Also there was a decrease in the catch per unit effort in the reservoir between 1973 and 1974.

Age composition of yellow perch in Lake Michigan changed dramatically over the three-year period. The dominant age group shifted from age III to age IV. Differences between Lake Michigan and the reservoir did not occur. Possible explanations for changes and differences are discussed.

Male yellow perch from Lake Michigan in 1973 had a significantly lower length-weight regression coefficient than males in 1972 or 1974. Female length-weight regressions did not change significantly over the three years.

The major food item of Lake Michigan yellow perch 136-235 mm TL changed from amphipods to fish over the three years. The major food items of perch longer than 235 mm TL were fish and crayfish. In the reservoir in 1973 there was an abundance of alewife young of the year. These were the major food item of yellow perch that year. The abundance of young alewives did not recur in the reservoir in 1974 and yellow perch shifted their feeding to sculpins and an occasional adult alewife. In the reservoir there were more empty stomachs in 1974 than in 1973.

76-000193 Kan, T. T. SYSTEMATICS, VARIATION, DISTRIBUTION, AND BIOLOGY OF LAMPREYS OF THE GENUS */LAMPETRA/* IN OREGON. Ph.D. dissertation, Oreg. State Univ. 204p. 1975. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. SFA 21(1).

Based on the number of velar tentacles and the form of longitudinal lingual laminae found in */Lampetra* (*Entosphenus*) *t. tridentata/* and its closely related forms, the taxon */Entosphenus/* should not be considered as a genus as commonly adopted, but, along with the taxa */Lethenteron/* and */Lampetra/*, should be regarded as a subgenus of the genus */Lampetra/*. The genus */Lampetra/* is distinct for various reasons, including particularly the character that no cusps are present in the area distal to the lateral circumorals. Six nominal species, belonging to the subgenera */Entosphenus/* and */Lampetra/*, have been known to occur in four of the seven major drainage systems of Oregon. (From Auth. Abstr.)

76-000194 Lewis, T. C.; Yerger, R. W. (Dep. Biol. Sci., Fla. State Univ., Tallahassee 32306) BIOLOGY OF FIVE SPECIES OF SEAROBINS (PISCES, TRIGLIDAE) FROM THE NORTHEASTERN GULF OF MEXICO. NOAA Fish. Bull. 74 (1): 93-103. Jan. 1976. SFA 21(1).

Geographically, Gulf population of *Prionotus alatus* appear to be restricted almost exclusively to the eastern portion of the Gulf of Mexico, while *Bellator militaris*/, *P. martis*/, *P. roseus*/, and *P. stearnsi*/ occur over the entire Gulf. Bathymetrically, *P. martis*/ is a shallow shelf species; *B. militaris*/ and *P. roseus*/, middle shelf species; *P. alatus*/, middle to deep shelf species; *P. stearnsi*/, deep shelf species. The size (standard length) of *B. militaris*/, *P. alatus*/, *P. martis*/, and *P. roseus*/ showed a significant positive correlation with increasing depth of capture. *Bellator militaris*/ showed a significant "preference" for fine sandy silt, clay, or mud bottoms. *Prionotus stearnsi*/ was captured in significantly greater numbers during daytime trawling and is postulated to swim actively in the water column at night. It appears to spawn from late summer to fall or early winter, while the remaining species spawn from fall to spring or early summer. Adult *P. stearnsi*/ differed in food habits by consistently consuming relatively large fishes, while juveniles of this species and all the age groups of the other four species fed consistently on crustaceans.

76-000195 Mason, J. C.; Machidori, S. (Fish. Mar. Serv., Pacific Biol. Stn., Nanaimo, BC V9R 5K6, Canada) POPULATIONS OF SYMPATRIC SCULPINS, *COTTUS ALEUTICUS*/ AND *COTTUS ASPER*/, IN FOUR ADJACENT SALMON-PRODUCING COASTAL STREAMS ON VANCOUVER ISLAND, B.C. NOAA Fish. Bull. 74 (1): 131-141. Jan. 1976. SFA 21(1).

General life history, distribution and abundance, age structure, and growth and survival are documented for sympatric populations of two cottid fishes. Stream obstructions may largely determine the distributional limits for both cottids with *Cottus aleuticus*/ penetrating farthest upstream. Biomass density and size of individual fish increased with distance upstream, largest individuals living at the upstream borders of their species ranges. Both sculpins were numerically most abundant in their lower ranges, reflecting the common estuarine origin of benthic young. From 69 to 74 percent of their combined biomass in the upper estuaries were *C. asper*/ while 75-100 percent was *C. aleuticus*/ in the upper stream zone. *Cottus asper*/ grew more rapidly and mortality rates were similar, but the oldest *C. aleuticus*/ was age 8 and 145 mm in length, compared with age 3 and 144 mm for *C. asper*/. The length-weight relation was similar for both species. The community role of these sculpins is explored with primary focus on possible competition with the stream-dwelling salmonids, and recommendations are made which might lead to increased production of salmonid smolts to the sea.

76-000196 Moyle, P. B.; Marciochi, A. (Div. Wildl. Fish., Univ. Calif., Davis 95616) BIOLOGY OF THE MODOC SUCKER, *CATOSTOMUS MICROPS*/, IN NORTHEASTERN CALIFORNIA. Copeia 1975 (3): 556-560. 5 Aug. 1975. SFA 21(1).

A study of the biology of the rare Modoc sucker (*Catostomus microps*/) was undertaken in Modoc and Lassen counties, California, in 1973. It appears to require small partially shaded streams with large muddy bottomed pools and is eliminated when the streams are channelized. Even where abundant, it is a minor part of the total fish fauna present. Their abundance was positively correlated with that of speckled dace (*Rhinichthys osculus*/) but negatively correlated with that of brown trout (*Salmo trutta*/), Pit sculpin (*Cottus pitensis*/), Sacramento sucker (*C. occidentalis*/) and Sacramento squawfish (*Ptychocheilus grandis*/). Their feeding habits and growth rates are

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similar to other members of the genus (*Catostomus*/ although they seldom grow larger than 15 cm SL or live longer than five years. They achieve maturity in their second or third year, spawning in April and May. Their small numbers, concentration in a few small streams, and susceptibility to channelization and hybridization with Sacramento suckers indicates they should continue to be managed as a threatened species.

76-000197 Newburg, H. J. (Minn. Dep. Nat. Resour., Sect. Fish., St. Paul 55155) REVIEW OF SELECTED LITERATURE ON LARGEMOUTH BASS LIFE HISTORY, ECOLOGY AND MANAGEMENT. Minn. Dep. Nat. Resour. Invest. Rep. No. 335. 75p. 1975. SFA 21(1).

A search of the literature pertaining to the management, ecology and life history of largemouth bass, *Micropterus salmoides* (Lacepede), was undertaken to provide fishery managers with a ready reference on the species and to provide direction for needed research, particularly in Minnesota waters. From the vast array of published material, an attempt has been made to confine the review to those references which are particularly pertinent to Minnesota conditions and problems or are basic to the general life history and ecology of the species. (Auth. Intro.)

76-000198 Soltz, D. L. VARIATION IN LIFE HISTORY AND SOCIAL ORGANIZATION OF SOME POPULATIONS OF NEVADA PUPFISH, *CYPRINODON NEVADENSIS*/. Ph.D. dissertation, Univ. Calif. (Los Angeles) 160p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(9), 1975. SFA 21(1).

Many aspects of the social organization and behavior of Nevada pupfish populations were found to vary markedly under different environmental situations. Non-reproductive adults in all populations studied formed schools or aggregations. However, reproductive males schooled with females and juveniles in the Amargosa River only. Feeding territories were defended by non-reproductive pupfish in habitats with large algae-free areas of substrate and minimal current (Big Spring; areas of the marsh). Three breeding systems were employed by different populations, and each was associated with a particular suite of ecological conditions as follows: (1) aggregative spawning occurred in flowing, variable temperature habitats; (2) breeding territoriality occurred in large to moderate size, constant temperature springs; (3) a dominance hierarchy occurred in small, constant and variable temperature springs. Laboratory studies indicated a possible genetically based difference in degree of aggressiveness between *C. n. amargosae* and *C. n. pectoralis*/. The various breeding systems and other aspects of social behavior are considered to be predominately phenotypic differences resulting from direct environmental feedback.

Reproduction is more strongly seasonal in the Amargosa River. Density fluctuates most in the Amargosa River and least in the small warm springs, where food appears to be consistently available. The populations differ from one another with respect to age at maturity. Maturity is delayed in females from the Amargosa River relative to those from Big Spring. The age structure of adult Amargosa River pupfish is indicative of higher adult survivorship. This population also apparently has higher adult growth rates. Females in the Amargosa River are more fecund at any given body size and grow to larger adult body size than females in Big Spring. Since both populations are producing essentially equal-sized eggs it is evident that Amargosa River pupfish put more effort into reproduction.

The life histories of these populations differ in the directions predicted by theory of r- and K-selection only in age specific fecundity. The apparent lack of correlation between most pupfish life history features and the constancy and temperatures of their

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environments may result from the effects of genetically invariant, temperature dependent metabolic processes on growth. (From Auth. Abstr.)

76-000199 Stillwell, C. E.; Casey, J. G. (NMFS, RR 7-A, Box 552-A, Narragansett, RI 02882) OBSERVATIONS ON THE BIGEYE THRESHER SHARK, *ALOPIAS SUPERCILIOSUS*, IN THE WESTERN NORTH ATLANTIC. NOAA Fish. Bull. 74 (1): 221-225. Jan. 1976. SFA 20(1).

76-000200 Waterman, J. J. (Tory Res. Stn., P.O. Box 31, 135 Abbey Rd., Aberdeen, AB9 8DG, Scotland) THE HADDOCK. Tory Res. Stn. Advis. Note No. 67. 13p. 1975. SFA 21(1).

This note summarized some general information about the haddock, and is intended to serve as useful background material for those in the industry who want to know more about this important commercial species. The information includes scientific names, common names and foreign names for haddock. The distinguishing features of the fish are described, and some notes are included on its life history. Information is also given on methods of capture, quantities landed and minimum legal size, together with notes on the composition of haddock and the shelf life of the principal products. The tables and graphs should be used only as a guide; individual haddock, like other fish, can vary considerably from the average. (Auth. Intro.)

76-000201 White, D. S. THE BIOLOGY OF *MINYTREMA MELANOPS*/ (RAFINESQUE), THE SPOTTED SUCKER. Ph.D. dissertation, Univ. Louisville 203p. 1974. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

Throughout the range, little variation was noted in the size, shape, color, or meristics. Variations were found in the breeding tubercle patterns and in spawning habits. Sex ratios were 1 to 1; however, males tended to die earlier. Age at maturity was from 1 to 4 years with maturation of females being related to age and maturation of males being related to size. Numbers of ova ranged from 19,500 to 51,000 and were correlated to both size of the fish and the number of previous spawnings. In the northern portions of the range, *Minytrema melanops*/ reproduced every second year as compared to each year in the southern habitats. Spawning began when the temperatures were greater than 12C. Early growth stages and pattern of scale formation were very similar to other catostomids; however, the yolk sac being divided into 3 lobes seems to be unique. Length-weight relationships, condition factors, and growth rates varied considerably among drainages. Growth and condition were much greater for lake specimens when compared with stream specimens. *Minytrema melanops*/ had distinct dawn-dusk feeding periods with the major foods being zooplankton and detritus.

The habitat of *Minytrema melanops*/ is one of small streams, oxbows, ponds, and lakes with an accumulation of debris and detritus. The spawning habitat requires deep, swift riffles over sand and gravel. Lack of suitable habitats create the boundaries of the range. The abundance and range are decreasing with siltation and channelization from urbanization and agriculture. Southern impoundments provide particularly good habitats, and the abundance of *Minytrema melanops*/ is increasing there. (From Auth. Abstr.)

POPULATION STUDIES, PRODUCTION, ETC.

76-000202 Bergersen, E. P. FISH PRODUCTION AND MOVEMENTS IN THE LOWER LOGAN RIVER, UTAH. Ph.D. dissertation, Utah State Univ. 183p. 1974. From Diss. Abstr. Int. B Sci. Eng. 36(1), 1975. SFA 21(1).

Following the abatement of domestic sewage pollution in the lower Logan River, the fish population was investigated in terms of abundance, growth, fecundity, production, mortality, age class structure, species diversity, distribution and movements during 1970 and 1971. Species diversity was predictable on the basis of four physical variables including percent riffle, a measure of bank cover, stream sinuosity and gradient. Percent riffle appeared to be the most important variable in predicting the "Trophic Condition Index" of the fish population. Of the four dominant species in the river (carp, mountain whitefish, Utah suckers, and brown trout) only the brown trout demonstrated an apparent response to the pollution abatement by reducing the extent of its movements at this time. Seasonal growth patterns were strikingly similar among the species examined with maximum growth occurring during the spring months. Extensive weight losses, attributed to high population densities and a decline in the invertebrate forage base, occurred during the summer of both 1970 and 1971, particularly in the older age classes of mountain whitefish and brown trout. Production of carp, mountain whitefish and brown trout and Utah suckers was assumed to approximate total fish production in the river. Whitefish production above and below 7-Mile Creek was estimated to be 3.87 and 1.65 gm/m²/yr respectively for the period June 1970 to May 1971. Carp production in these two areas was estimated to be 22.86 and 10.45 gm/m²/yr for the same period. Brown trout production was estimated to be 5.94 gm/m²/yr above 7-Mile Creek while production of Utah suckers in the study area was estimated to be 2-3 gm/m²/yr. Weighted production for the entire study area was estimated to be 23.5 gm/m²/yr. Evidence is presented which suggests that fish production has increased following the pollution abatement. (From Auth. Abstr.)

76-000203 Bisson, P. A. ELEVATED TEMPERATURE AND THE PRODUCTION OF JUVENILE CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*) IN A MODEL STREAM. Ph.D. dissertation, Oreg. State Univ. 86p. 1975. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. SFA 21(1).

Temperature was elevated approximately 4 C in a model stream relative to an unheated, but otherwise similar control stream. The streams were located outdoors, received identical amounts of exchange water from a nearby creek, and followed natural diurnal and seasonal temperature cycles. Juvenile spring chinook salmon (*Oncorhynchus tshawytscha*) were introduced into each stream and allowed to remain about 1 year until the following winter. Their production was measured tri-weekly and related to changes in temperature, food availability, and other environmental factors. Ancillary experiments utilizing water from the model streams measured changes in pre-feeding survival and weight and differences in growth efficiencies at various rations. Two year-classes of juvenile salmon were studied.

Chinook production in the unheated control stream exceeded that in the heated stream. In 1972 total production was twofold greater and in 1973 it was about 30 percent higher. Elevated temperature lowered productivity of the heated stream by causing increased mortality of eggs and fry and reduced growth efficiencies of juveniles as food became less abundant. It also resulted in lower biomasses of food organisms, either because the experimental elevation directly affected survival and growth of benthic invertebrates or because increased siltation associated with heavier growths of filamentous algae made

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riffle substrate less suitable for immature stages of certain insects. Beneficial effects of increased temperature included protection from infection by a trematode parasite (*Nanophyetus salminalis*) and, possibly, increased tendencies of some invertebrates to enter the drift.

76-000204 Kapetsky, J. M. GROWTH, MORTALITY, AND PRODUCTION OF FIVE FISH SPECIES OF THE KAFUE RIVER FLOODPLAIN, ZAMBIA. Ph.D. dissertation, Univ. Mich. 205p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. SFA 21(1).

The field work was conducted on the Kafue River floodplain, Zambia, Africa, in 1970 before the Kafue River was impounded. Twenty-six population estimates were made by seining and chemofishing in the principal fish habitats during the low-water period of 1970. The five species selected for special study, *Sarotherodon andersoni*, *S. macrochir*, *Tilapia rendalli*, *Serranochromis angusticeps*, and *Hepsetus odot* comprised 61 percent of the average low-water standing crop of 540 kg/ha.

Marks on the scales of individuals of each of the five species were validated, and scales were used for aging and for back-calculation of length increments. From 58 percent to 95 percent of the annual variations in the first and second year length increments of *S. andersoni* and *S. macrochir* were accounted for by corresponding annual variations in the hydrological regime or by annual variations in cold season temperatures, or by combinations of the two variables. Annual growth in length, averaged for a number of years, was approximately linear for each of the five species, but the evidence indicated that growth rates varied seasonally.

Annual mortality rates were apparently high for the third year of life of each species, from 92 percent to 99 percent, but decreased and were approximately constant for the latter years of life. The available information suggested that natural mortality rates were highest during the time when the floodwaters were receding from the floodplain, and that they also were high during the low water period.

Aggregate production for fishes of age 2 and older was 181 kg/ha/yr, but varied from 6 kg/ha/yr to 76 kg/ha/yr among the five species.

In comparison with production estimates from other tropical and temperate systems, fish production on the Kafue River floodplain was not as high as expected, and fishery yield was low in comparison with other African floodplains and in relation to yield from African lakes. Fish production in the ecosystem may be limited inherently by restrictions of space imposed by fluctuations in the hydrological regime and by the low fertility of the floodplain soils. Recent man-induced changes in the ecosystem, most importantly intensive exploitation of fishes, have resulted in lowered fish production. (From Auth. Abstr.)

76-000205 Kingsbury, A.; Larson, P.; Downey, G. (Alaska Dep. Fish Game, Subport Bldg., Juneau 99801) FORECAST OF THE 1975 PINK SALMON RETURNS TO SOUTHEASTERN ALASKA. Alaska Dep. Fish Game Inf. Leaflet No. 168. i + 33p. 1975. SFA 21(1).

The southeastern Alaska pink salmon forecast is based on the relationship between pre-emergent fry abundance, air temperature and subsequent adult returns. In 1975 the northern Southeastern pink salmon return is expected to be 4.8 million with a possible range of 1.6 to 8.0 million. An extremely weak return of about 2.1 million with a possible upper range of 4.1 million is expected for southern Southeastern. Forecasts by district and time segment indicate considerable variation in run strength. In some areas runs are expected to be so weak that even without fishing, it is unlikely that escapement goals can be achieved. In southern Southeastern the harvest

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will have to be restricted even if the return is in the upper range of the forecast. A harvest in excess of 300,000 pinks is very unlikely. The point estimate of the harvest in northern Southeastern is 1.3 million, however, the catch should be within the range of 0 to 4.0 million.

76-000206 Moring, J. R. (Oreg. Wildl. Comm., 303 Extension Hall, Oreg. State Univ., Corvallis 97331) ESTIMATES OF POPULATION SIZE FOR TIDEPOOL SCULPINS, *OLIGOCOTTUS MACULOSUS*, AND OTHER INTERTIDAL FISHES, TRINIDAD BAY, HUMBOLDT COUNTY, CALIFORNIA. Calif. Fish Game 62 (1): 65-72. Jan. 1976. SFA 21(1).

Intertidal fishes were marked and recaptured during a 12-month study, December 1968 to December 1969. Three adjacent zones of a relatively undisturbed intertidal area in Trinidad Bay, California, were used in the experimental work. A total of 1124 fishes was marked and 69 were recaptured (6.1 percent). Schnabel, Modified Schnabel, and Schumacher-Zschmeyer population estimates were computed for the total population, and for the most common species, *Oligocottus maculosus*. Several modified estimates were derived for the intertidal environment to eliminate the effects of seasonal fishes and recruitment of young cottids. Indications of the sizes and densities of the seasonally fluctuating fish populations are given for spring, summer, fall, and winter. There was no evidence of significant lateral movement of *Oligocottus maculosus* or other species. The ecological implications of the study are discussed.

76-000207 Nelson, W. R. LARVAL TRANSPORT AND YEAR-CLASS STRENGTH OF ATLANTIC MENHADEN. Ph.D. dissertation, Univ. South. Miss. 160p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(8), 1976. SFA 21(1).

A Ricker spawner-recruit model was developed for Atlantic menhaden, *Brevoortia tyrannus*, from data on the 1955-1970 year classes. The number of eggs produced by the spawning stock was calculated as the independent variable to account for changes in fecundity due to changes in population size and age structure. A survival index was developed from deviations around the Ricker curve and was regressed on several environmental parameters to determine their density-independent effects. The recruit-environment model accounted for over 84 percent of the variation in the survival index. Zonal Ekman transport, which acts as a mechanism to transport larval menhaden from offshore spawning grounds to inshore nursery grounds, was the most significant parameter tested. Intensive biological and oceanographic studies in Onslow Bay, North Carolina, indicated a real relationship between Ekman transport and the distribution of larval Atlantic Menhaden. Ricker functions for good and poor environmental years were developed, indicating the wide range of recruitment that can be expected at different stock sizes. Comparisons of spawner-recruit relations for Pacific sardine and Atlantic menhaden indicated striking similarities. Surplus yield for the Atlantic menhaden fishery was calculated from observed and predicted survival and compared with the actual performance of the fishery.

76-000208 O'Connor, J. F. ON THE BROOK TROUT (*SALVELINUS FONTINALIS*,) PRODUCTION AND TROPHIC DYNAMICS OF FOUR STREAMS IN THE MATAMEK RIVER SYSTEM, QUEBEC. Ph.D. dissertation, Univ. Waterloo 1975. From Diss. Abstr. Int. B Sci. Eng. 36(5), 1975. SFA 21(1).

Kaikhosru Creek was an excellent nursery stream and it produced 60.95 and 66.37 kg/ha/yr in 1971 and 1972. This was principally due to fry and yearlings which contributed 78 and 82 percent of the total production in the two years. Gallienne Creek, although deep and well sheltered, contained no spawning areas and little suitable fry

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habitat. It produced 38.77 and 37.01 kg/ha/yr in 1971 and 1972. The Tchinicaman River was a wide, shallow, swiftly flowing river and although it contained spawning areas, trout density was low because of the limited amount of suitable shelter. Only 15.35 kg/ha and 16.12 kg/ha were produced in this river in 1971 and 1972. Sherry Creek was a small, shallow slow flowing creek which lacked spawning areas and deep pools. Fish migrated from the stream during the warmer periods of the summer in 1972 and 1973. The resulting production estimates for this creek for 1971, 1972 and 1973 were 40.92, 21.01, and 14.47 kg/ha/yr.

Generally, trout were opportunistic feeders and in most instances the volume of food organisms in the diet could not be closely related to the volumes in the drift or benthos. They fed heavily on aquatic organisms during the spring run-off but as the summer progressed water levels fell, drift rates decreased and the trout depended more upon terrestrial insects to supplement their diet. However, in the Tchinicaman River the trout could rely on an abundance of Simuliidae larvae in the drift and benthos and terrestrial organisms were not as important in their mid summer diet as they were in other streams.

Production in Kaikhosru and Gallienne was primarily food limited and in Sherry and Tchinicaman production was low because of lack of suitable space from which to exploit the food that was available. (From Auth. Abstr.)

76-000209 O'Connor, J. F.; Power, G. (Dep. Mines, Resour. Environ. Manage., Winnipeg, MB R3W 0W4, Canada) PRODUCTION BY BROOK TROUT (*SALVELINUS FONTINALIS*) IN FOUR STREAMS IN THE MATAMEK WATERSHED, QUEBEC. J. Fish. Res. Board Can. 33 (1): 6-18. Jan. 1976. In English with French summ. SFA 21(1).

Production by brook trout (*Salvelinus fontinalis*) in four infertile streams on the Canadian Precambrian Shield was estimated to be between 14.5 and 66.4 kg/ha per yr during 3 successive yr of study (1971-73). These values represent the range of total fish flesh elaborated annually in these streams because trout was the only species present. Differences between streams in annual production and P:B ratios arose from variations in stream cover (and its effect on carrying capacity), recruitment, and total biomass. Variations in age-specific growth rates were not critical. Production in the two most productive streams was judged to be controlled by food, while in the other two streams lack of suitable cover for adult trout limited production.

76-000210 Parrish, R. H. (Oreg. State Univ., Corvallis 97331) EXPLOITATION AND RECRUITMENT OF PACIFIC MACKEREL, *SCOMBER JAPONICUS*, IN THE NORTHEASTERN PACIFIC. Calif. Coop. Oceanic Fish. Invest. Rep. 17: 136-140. Oct. 1974. SFA 21(1).

76-000211 Smith, C. L.; Tyler, J. C. (Dep. Ichthyol. Am. Mus. Nat. Hist., Central Park West at 79th St., New York, NY 10024) SUCCESSION AND STABILITY IN FISH COMMUNITIES OF DOME-SHAPED PATCH REEFS IN THE WEST INDIES. Am. Mus. Novit. No. 2572. 18p. Apr. 1975. SFA 21(1).

The scleractinian coral *Montastrea annularis* often forms dome-shaped heads that may reach a diameter of 5 m. Eventually these heads become too large to support their own weight and they collapse, leaving a base on which other corals can grow and ultimately form complex patch reefs. We have studied the fishes associated with reefs in the solid colony stage, small, middle-sized, and large domes, and partially collapsed domes. One reef was censused in 1970 and again in 1973. Between visits part of the reef had collapsed reducing the amount of large shelters available for cardinalfishes (*Apogonidae*), squirrelfishes (*Holocentridae*), and grunts (*Pomadasysidae*).

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Concomitantly there was a dramatic increase in the population of gobies (/Gobiidae/) and blennies (/Clinidae/). Nevertheless, there was little change in the total number of species and individuals inhabiting the reef. An analysis of the sizes of the infaunal residents can provide a measure of niche utilization and equilibrium. A model is presented to show how size of the individual fish functions in the regulation of species composition and population structure within reef fish communities.

76-000212 Sterck, T. W. PRODUCTION AND POPULATION DYNAMICS OF TWO FISHES IN A SMALL WOODLAND STREAM. Ph.D. dissertation, Ohio State Univ. 196f. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(8), 1975. SFA 21(1).

The production ecology of two species of fish, the creek chub, /Semotilus atromaculatus/, and the redbelly dace, /Phoxinus erythrogaster/, was studied in a small headwater stream in southeastern Ohio. Creek chub production was 14.06 g/m²/yr., 60 percent of which occurred in the first summer of life. Redbelly dace production was 2.62 g/m²/yr., 57 percent of which occurred in the first summer of life. Creek chubs did not grow during the winter (October to April) and thus production was zero during this interval. Redbelly dace grew during the winter but production was small compared to summer. Creek chub standing crop was greatest in autumn and least in spring and turnover rate for this species was 1.47. Redbelly dace standing crop was greatest in summer and least in fall and annual turnover rate for this species was 2.07. Although the stream studied was relatively infertile, fish production compared favorably with other small streams. Thus, dependence on allochthonous based food chains is suspected.

A large proportion of the mature fish of both species undertook upstream spawning migrations. Distances traveled were small however, generally less than 300 meters. Many immature creek chubs but few immature redbelly dace also undertook small movements. Mature fish did not move downstream in large numbers but young of the year did drift downstream in early summer.

A beaver pond located at the downstream end of the study area had a major impact on the ecology of the species considered. Most upstream movement was initiated in this pond and standing crops were greater there than any other stream section. Evidence was presented which indicated that creek chub nesting distribution was a function of distance from the beaver pond.

SPAWNING HABITS AND MOVEMENTS, FECUNDITY, ETC.

76-000213 Andreassen, J. K.; Earnes, J. R. (Wildl. Fish., Univ. Alaska, Fairbanks 99701) REPRODUCTIVE LIFE HISTORY OF /CATOSTOMUS ARDENS/ AND /C. DISCOBOLUS/ IN THE WEBER RIVER, UTAH. Copeia 1975 (4): 643-648. 31 Dec. 1975. SFA 21(1).

The yearly reproductive cycle in /Catostomus ardens/ and /C. discobolus/ was studied by means of gonad indices, histological sections of the testes and measurements of oocyte diameters. Spermatocytes proliferated rapidly following spawning and spermatozoa overwinter in the lobules of the testes. Recruitment oocytes (less than .45 mm) are present in the ovary the entire year. The largest oocytes gradually increase in size until they are spawned during May to July in /C. discobolus/ and during mid May to mid June in /C. ardens/. Spawning in 1972 occurred in a period of maximum water temperature. The gonad index data correlated well with the stages of development of the testes and with increasing oocyte diameter.

76-000214 Brown, A. K. BREEDING TERRITORIES IN TWO FRESHWATER FISHES OF THE GENUS /CYPRINODON/ (PISCES, CYPRINOLONTIACAE) IN SOUTHWESTERN UNITED STATES. Ph.D. dissertation, Univ. South. Calif. 152p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(3), 1975. SFA 21(1).

The territorial breeding system of two species of pupfish /Cyprinodon sp. nov./ and /C. nevadensis/ was studied in the field. Territories of these species of /Cyprinodon/ are sites of courtship and spawning that are defended by reproductively active males. Males usually defend breeding territories during the peak of the reproductive season when population densities are high, breeding habitat is limited, and competition between males for territories in spawning areas is intense. Only a small proportion (5 to 10 percent) of males in the population are sufficiently large (approximately 35 mm standard length), vigorous, and aggressive to secure territories and reproduce.

Size of territories is determined by the intensity of competition for breeding sites and usually is inversely proportional to the density of breeding males.

The breeding system of /Cyprinodon/ is plastic and varies within and between populations in response to population density and characteristics of the habitat. A simple model is presented that can account for the evolution of the territorial breeding system in terms of selective pressures resulting from environmental parameters and behavioral interactions. (From Auth. Abstr.)

76-000215 Fernholm, E. (Dep. Zool., Univ. Stockholm, Sweden) OVULATION AND EGGS OF THE HAGFISH /EPTATRETUS BURGERI/. Acta Zool. (Stockh.) 56 (3): 199-204. 1975. SFA 21(1).

Ripe females and males of /Eptatretus burgeri/ were kept in cages both in the sea and in the aquaria for about 2 months of the normal spawning period around October. All the 9 ripe females in the sea ovulated all their eggs (200) and deposited 178 of them. Only 5 eggs were ovulated and deposited in the aquaria, although there were 17 ripe females and some of them were injected with varicous hormones in an effort to induce ovulation. No eggs were fertilized. A peculiar surface pattern of hexagonal ridges is described around the entrance of the micropylar canal on the bottom of the micropylar funnel in the ovulated eggs.

76-000216 George, C. J.; Gordon, J. H. II (Dep. Biol. Sci., Union Coll., Schenectady, NY 12308) OBSERVATIONS ON THE RAINBOW SMELT IN LAKE GEORGE, NEW YORK. N. Y. Fish Game J. 23 (1): 13-19. Jan. 1976. SFA 21(1).

Observations on spawning runs of rainbow smelt (/Osmerus mordax/) in Smith Bay Brook and Hague Brook, tributaries of Lake George, during April 1974 are presented. These are thought to have been the first for this lake. The spawning fish belonged predominantly to the 0+ age group. Implications of the presence of smelt in the ecosystem are discussed.



76-000217 Hain, J. H. W. MIGRATORY ORIENTATION IN THE AMERICAN EEL, /*ANGUILLA ROSTRATA*/. Ph.D. dissertation, Univ. R. I. 143p. 1975. From Diss. Abstr. Int. E Sci. Eng. 36(9), 1976. SFA 21(1).

Migratory orientation in elvers was studied in a 1.56 m. Y-tank. Emphasis was placed on unconditioned responses to natural olfactory stimuli occurring in the freshwater environment. The behavioral assay technique involved establishing a baseline by recording responses to increasing dilutions of natural stream water, a known "attractant". Experimental stimuli were prepared by "addition" of various prepared rinses to a "blank" or well water "carrier". These additive experiments identified certain aquatic plant and leaf detritus as contributors to the upstream stimulus. The suggestion is that these stimulus sources have a complimentary or synergistic effect. Perception of the stimuli was olfactory and the response an unconditioned one.

The behavior of migratory silver eels and immature yellow eels, the control group, was studied in a 5.49 m. choice-chamber apparatus. Silver eels displayed a negative rheotaxis in both well water and natural stream water, but reversed the sign of their response, to a positive rheotaxis, when salt water was introduced into the tank. The orientation appeared to precede a change in the migratory environment, suggesting that behavior as well as morphology and physiology anticipate the upcoming migration. Yellow eels showed no rheotactic response in August, but displayed a negative rheotaxis two months later into the fall. This seasonal difference suggests a periodic movement away from the home range in what might constitute a "dry-run" for the eventual offshore migration. In heterogeneous samples, yellow and silver eels showed similar rheotactic responses in fresh water, but were segregated by response in salt water. Silver eels perceived salt water through an olfactory mechanism.

The locomotor activity of silver eels peaked to coincide with periods of naturally occurring darkness, between sunset and moonrise. Exogenous control over locomotor activity was suggested by experiments which induced activity during daylight hours, however, there is also evidence for an endogenous component. The relationship between eel migration and lunar period is discussed with respect to these data. (From Auth. Abstr.)

76-000218 Hausle, D. A.; Coble, D. W. (Box 698, NCRI, Dep. Game, Fish, Parks, Pierre, SD 57501) INFLUENCE OF SAND IN BEDS ON SURVIVAL AND EMERGENCE OF BROOK TROUT (/SALVELINUS FONTINALIS/). Trans. Am. Fish. Soc. 105 (1): 57-63. Jan. 1976. SFA 21(1).

Alevins of brook trout (/Salvelinus fontinalis/) were buried in laboratory troughs in spawning gravel containing 0 to 25 percent sand. Sand slowed emergence and reduced the number of fry emerging. Weight of fry was not related to proportion of sand in the gravel, but was related to time; the fry were heaviest near the time of peak emergence, and lighter before and after the peak. Survival was estimated to be 84 percent from egg deposition to hatching for brook trout in Lawrence Creek, Wisconsin, and 70 percent from hatching to emergence, providing a total estimate for survival from egg deposition to emergence of 59 percent.

SPORT FISHERY ABSTRACTS

76-000219 Kohlhorst, D. W. (Calif. Dep. Fish Game, Sacramento 95814) STURGEON SPAWNING IN THE SACRAMENTO RIVER IN 1973, AS DETERMINED BY DISTRIBUTION OF LARVAE. Calif. Fish Game 62 (1): 32-40. Jan. 1976. SFA 21(1).

To determine the time and location of sturgeon spawning in the Sacramento River, California, sampling was conducted three times per week from March 5 to June 17, 1973, at six locations from the mouth of the Feather River to above Red Bluff. A total of 246 larvae and nine eggs was collected at the mouth of the Feather River, at river km 180 (river mile 112), and at Colusa. Spawning probably occurred from the vicinity of Knights Landing to just above Colusa. Spawning occurred from mid-February to late May, although the majority (93 percent) was in March and April. Water temperatures during those 2 months ranged from 7.8 to 17.8 C (46 to 64 F). Spawning peaked from April 8 to 17 at a temperature of approximately 14.4 C (58 F). Mean size of larvae increased each month, probably because the growth rate increased with water temperature. Both white sturgeon (*Acipenser transmontanus*) and green sturgeon (*A. medirostris*) occur in the Sacramento-San Joaquin Estuary. While the larvae could not be identified, most were probably white sturgeon since that species dominates the Sacramento River sturgeon fishery.

76-000220 Lowe, T. P. REPRODUCTIVE ECOLOGY OF CYSTER TOADFISH (*OPSANUS TAU*) IN CHARLESTOWN POND, RHODE ISLAND. Ph.D. dissertation, Univ. R. I. 135p. 1975. from Diss. Abstr. Int. B Sci. Eng. 36(5), 1975. SFA 21(1).

In this investigation several other aspects of the general reproductive ecology, the importance of guarding the eggs and fry against predation, and the role of fanning in waste removal and maintaining adequate oxygen levels among oyster toadfish were studied. Spawning began about May 20, when surface temperatures reached 16 to 17°C and terminated about July 10 to 15 when surface temperatures were approximately 23°C in the vicinity of the tiles. Toadfish preferred spawning on the northern grassy slope of the pond instead of the sandy slope. They also seemed to prefer a spawning site with one opening instead of two. There may be migration of toadfish into shallow areas during the spawning season with the females individually moving back into the deeper areas after they have spawned. There was no migration into and out of Charlestown Pond. Males spawned with as many as three females. Maximum egg development in the female was observed between August 7 to September 26 in 1970. Males ranged in length from 165 to 337 mm and averaged 254 mm. Females ranged from 132 to 301 mm and averaged 182 mm. Sex ratios of males to females in the western part of the pond varied from 1.89:1 to 2.5:1.

Unguarded eggs and fry in 20 localized tiles were eaten within eight hours, those in 32 scatter tiles were eaten within four days. Predators included American Eels (*Anguilla rostrata*), blue crabs (*Callinectes sapidus*), and mud snails (*Nassarius trivittatus*). Attended and unattended eggs in the laboratory hatched between 24 and 26 days of age. Mean oxygen consumption of eggs and fry varied from approximately 18 ul/gr/hr before formation of the primitive streak to approximately 510 ul/gr/hr in fry with developed pigment. Oxygen consumption was not significantly different among eggs and fry exposed to 50, 100, and 150 mg of ammonia or exposed to pH levels of 7.65, 7.4, and 6.95. However, oxygen consumption among eggs in the primitive streak stage exposed to 200 mg ammonia and among fry shortly after hatching exposed to 50 mg of ammonia was significantly different than the controls. (From Auth. Abstr.)

76-000221 Merriner, J. V. (Va. Inst. Mar. Sci., Gloucester Point 23062) ASPECTS OF THE REPRODUCTIVE BIOLOGY OF THE WEAKFISH, /CYNOSCION REGALIS/ (SCIAENIDAE), IN NORTH CAROLINA. NOAA Fish. Bull. 74 (1): 18-26. Jan. 1976. SFA 21(1).

The weakfish, /Cynoscion regalis/, has an extended spawning season in North Carolina's inshore waters (males are ripe March to August, and females are ripe April to August). Peak spawning activity occurs from late April through June. The extended spawning season throughout the range is a major factor in variability of size within a year class.

Published accounts cite attainment of sexual maturity at age II for males and age III for females. I conclude that weakfish of both sexes reach sexual maturity as yearling fish, although some smaller members of a year class do not mature until their second year.

Weight and length of weakfish are better indicators of fecundity than is age (higher correlation coefficients). A female weakfish of 500 mm standard length produces slightly over two million eggs.

76-000222 Muth, S. E.; Tarter, D. C. (McClintic Wildl. Stn., Pt. Pleasant, WV 25550) REPRODUCTIVE BIOLOGY OF THE TROUT PERCH, /PERCOPSIS OMISCOMAYCUS/ (WALBAUM), IN BEECH FORK OF TWELVEPOLE CREEK, WAYNE COUNTY, WEST VIRGINIA. Am. Midl. Nat. 93 (2): 434-439. Apr. 1975. SFA 21(1).

Gonad weight-body weight relationships, seasonal development of cva, fecundity, sexual dimorphism, sex ratios and sexual maturity were determined for the trout perch, /Percopsis omiscomaycus/ (Walbaum), from Beech Fork of Twelvepole Creek, Wayne Co., West Virginia. Mean gonad weights (expressed as percent of body weight) reached maxima in both males (5.89 percent) and females (13.11 percent) by April. The largest average diam of ova, 1.18 mm (range, 0.84-1.63 mm), was recorded in the spring. There was a high correlation ($r = 0.98$) between fecundity and total length of females. Total egg counts ranged from 145 to 1112; the average was 346. Depths of caudal peduncle and anus to caudal base were significantly greater in females. Sex ratios, based on fish collected throughout the year, were significantly different from 1:1. But, when the fish from the May collection were omitted, no significant deviation was observable.

76-000223 Ross, M. R. THE BREEDING BEHAVIOR AND HYBRIDIZATION POTENTIAL OF THE NORTHERN CREEK CHUB /SEMOTILUS ATROMACULATUS ATROMACULATUS/ (MITCHELL). Ph.D. dissertation, Ohio State Univ. 174p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(3), 1975. SFA 21(1).

Nest-entry behavior of females appeared to be affected by habitat. Male nest-building rates increased during periods of active spawning, indicating a major function of this behavior is egg protection. Male aggression was directed most consistently toward other male creek chubs, not egg predators. Tubercles and relative head size of males were found to increase with age and size. These characters appear to be visual stimuli indicating status or rank to others. The intensity of aggression shown by nesting male creek chubs was inversely correlated to the size of the nesting male, and increased as the size difference between a nesting male and nest-intruder decreased.

Experimental hybridization was conducted between the creek chub and other genera reported to hybridize with /Semotilus atromaculatus/ in nature. All hybrid combinations were found to be intermediate between the parent species, although many specific characters of the hybrids were not intermediate. The hybrid /S. atromaculatus/ x /C. anomalum/ did not correlate to a published description.

Four of the six intergeneric hybrid combinations had survival rates to larval stages approximately equal to control crosses. Therefore,

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the frequency of intergeneric hybrids of the creek chub found in nature is probably not due to differing degrees of infertility, but to temporal, spatial, and behavioral characteristics of the interacting species. (From Auth. Abstr.)

76-000224 Tuunainen, P. ON THE SEASONAL MIGRATIONS OF THE RIVER-SPAWNING WHITEFISH, /COREGONUS PIDSCIAN/ (GMELIN), IN AN ARCTIC WATERCOURSE. Int. Ver. Theor. Angew. Limnol. Verh. 19: 2538-2545. Dec. 1975. SFA 21(1).

76-000225 Tyler, A. V.; Dunn, R. S. (Dep. Fish. Wildl., Mar. Sci. Cent., Oreg. State Univ., Newport 97365) RATION, GROWTH, AND MEASURES OF SOMATIC AND ORGAN CONDITION IN RELATION TO MEAL FREQUENCY IN WINTER FLOUNDER, /PSEUDOPLEURONECTES AMERICANUS/, WITH HYPOTHESES REGARDING POPULATION HOMEOSTATIS. J. Fish. Res. Board Can. 33 (1): 63-75. Jan. 1976. In English with French summ. SFA 21(1).

Six ration levels were established among 120 large, adult winter flounder (/Pseudopleuronectes americanus/) by setting different feeding frequencies, but with unlimited feeding at each meal. All fish were maintained at 7 C. With decrease in feeding frequency, fish ate less food per month but more food per meal--i.e. ration compensation was attempted. At the lowest frequency, two meals per month, fish did not compensate. At any one feeding frequency, fish ate progressively more per meal from the first to the fourth (final) month of the experiment.

Maintenance ration was 7.9 gcal/g per day. Weight loss on starvation was equivalent to 2.14-2.35 gcal/g per day. Gross conversion efficiency ranged from 1 to 16 percent, and was positively correlated with ration. Net conversion efficiency averages 24.3 percent and was not related to ration.

Positive correlations were found between mean calories consumed per day and condition, liver weight, percent fat in the liver, percent of fish with yolk-bearing ovaries, ovary weight, and percent of ovarian follicles with yolk. The decrease in proportion of yolked oocytes with decrease in ration was not due to increased follicular atresia, but to a decrease in number of oocytes starting vitellogenesis.

Comparisons with flounders sampled directly from Passamaquoddy Bay, N.B. showed that the negative correlation between condition index and percentage of oocytes not in vitellogenesis was the same for Bay and laboratory fish, the range of response being greater in the laboratory fish. The existence of this relationship was interpreted as evidence that some flounder within the Bay were not getting all the food they could use. In the face of food scarcity, the winter flounder's adaptive reproductive strategy seems to be to sacrifice egg production and maintain body weight, and so when a good year comes its body will be large and able to carry a larger ovary.

MOVEMENTS, SEASONAL AND DEPTH DISTRIBUTION, ETC.

76-000226 Bond, G. W. III VERTICAL DISTRIBUTION AND LIFE HISTORIES OF THE GONOSTOMATID FISHES (PISCES: GONOSTOMATIDAE) OFF BERMUDA. Ph.D. dissertation, Univ. R. I. 299p. 1974. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

/Gonostoma elongatum/, /Pollichthys maui/ and /Vinciguerria poweriae/ exhibit diel vertical migrations of 200 to about 500 meters, while /Vinciguerria attenuata/ migrates about 100 meters. The remaining seven abundant species (/Bonapartia pedaliota/, /Cyclothone braueri/, /C. microdon/, /C. pallida/, /C. pseudopallida/,

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/Icthyococcus ovatus/ and /Margrethia obtusirostra/) apparently do not migrate. Breeding seasons were determined for the above eleven species. /C. pallida/, /C. pseudopallida/, /G. elongatum/, /I. cvatus/ and /V. poweriae/ exhibit peak spawning activity during the productive Spring and Summer months. The spawning periods of the remaining six species at least partly overlap into the Spring-Summer period (/M. obtusirostra/ and /P. maui/, Summer-Fall; /C. braueri/, /C. microdon/ and /V. attenuata/, Winter-Spring; and /B. pedaliota/, Spring and Fall). Together the differences in time of spawning and diel vertical migration patterns effectively afford ecological separation between all species found associated at the same daytime depths. A tendency to form aggregations or "clumps" was noted in several species. The data, particularly for the three species found clumped primarily at night, suggest that some species of Gonostomatidae aggregate during the period of feeding activity. The species of Gonostomatidae off Bermuda contribute to the catch rates of ichthyofauna between the surface and 1550 meters at night, and below 150 meters during the day. By far the most abundant species in all seasons are the non-migrating /C. braueri/, /C. microdon/ and /C. pallida/, which comprise the majority of the catch between 400-700 m, 700-1100 m, and below 1100 m, respectively. (From Auth. Abstr.)

76-000227 Day, D. E. (Wash. State Dep. Fish., Fish. Cent., Univ. Wash., Seattle 98195) HOMING BEHAVIOR AND POPULATION STRATIFICATION IN CENTRAL PUGET SOUND ENGLISH SOLE (/PAROPHRYS VETULUS/). J. Fish. Res. Board Can. 33 (2): 278-282. Feb. 1976. In English with French summ. SPA 21(1).

Tag recovery data for a central Puget Sound English sole (/Parophrys vetulus/) tagging study in which fish captured at some locations were tagged and released at others suggested the homing of some fish back to their locations of capture. The occurrence of significant homing was verified through an analysis of tag recovery rates at locations of initial capture and locations of release during successive time intervals. The analysis also revealed that fish not displaced during tagging remained essentially at their locations of original capture. These observations evidenced rigid geographic stratification of the population represented by the tagged fish.

Both tag recovery data and catch-per-unit-effort data suggested the migration of some English sole out of the area and/or depths of fishing during fall-winter months.

76-000228 Nakamura, R. (Dep. Biol., Southeast. Mass. Univ., North Dartmouth 02747) TEMPERATURE AND THE VERTICAL DISTRIBUTION OF TWO TIDEPOL FISHES (/OLIGOCOTTUS MACULOSUS/, /O. SNYDERI/). Copeia 1976 (1): 143-152. 12 Mar. 1976. SPA 21(1).

The relationship between the tide cycle, microhabitat, temperatures, microdistribution patterns and thermal physiology of /Oligocottus maculosus/, and /O. snyderi/, two tidepool cottids, was determined. Upper level tidepools generally are characterized by greater temperature extremes and sudden temperature shifts which are directly related to the periods of emergence and subemergence. Lower tidepools tend to be more stable with a lesser extent of temperature extremes. /Oligocottus snyderi/, which is restricted to middle and lower tidepools, is less tolerant of wide temperature extremes. Its upper distributional boundaries appear to be governed by tidepool temperature extremes. /Oligocottus maculosus/, which is widely distributed but concentrated in upper level tidepools, is able to tolerate temperatures greater than those occurring in upper pools. Both species do not appear to be adversely affected by sudden temperature shifts.

76-000229 Nolan, R. S. THE ECOLOGY OF PATCH REEF FISHES. Ph.D. dissertation, Univ. Calif. (San Diego) 246p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36 (8), 1976. SFA 21(1).

The fishes of the patch reef assemblage are very diverse and most are restricted to the immediate proximity of the reef. Fishes belonging to other nearby lagoon assemblages also seek shelter in patch reefs when quiescent at night. The species composition of the patch reef assemblage varied considerably about an equilibrium value over an observation period of two and a half years. Likewise, the variability found in defaunation collections of comparable reefs was found to be high.

The colonization of defaunated natural reefs was characterized by the early invasion and persistence of 17 species--of which /*Pomacentrus pavo*/, /*P. vaiuli*/, /*Paramia quinquelineata*/, and /*Apogon novaeaguineae*/ were the most frequent. No defaunated reef ever achieved the exact predefaunation composition; and in many cases, the species composition at 600 days differed markedly from that of the baseline condition. The reefs did, however, attain a species number comparable to the original state. The characteristic oscillation about a value of about 22 species (accountable by census) following defaunation, supports the equilibrium theory of island colination. Short-term rates of immigration that were measured within ten days of defaunation adequately predicted the equilibrium number of species found after 100 to 200 days. (From Auth. Abstr.)

76-000230 Pristas, P. J.; Levi, E. J.; Dryfoos, R. L. (NMFS, Panama City Lab., Panama City, FL 32401) ANALYSIS OF RETURNS OF TAGGED GULF MENHADEN. NOAA Fish. Bull. 74 (1): 112-117. Jan. 1976. SFA 21(1).

From 1969 to 1971 nearly 76,000 adult Gulf menhaden, /*Brevoortia patronus*/, were tagged in the northern Gulf of Mexico with internal metallic tags. From an estimated 28,000 recaptures it was concluded that there is little east-west movement of adult Gulf menhaden during the fishing season from April to October, and that there is little mixing of menhaden from different areas when fish move offshore during the winter. Total mortality appears to be high, but could not be estimated from the returns. Few Gulf menhaden survive more than 3 yr.

76-000231 Serns, S. L. (Water Resour. Res., Dep. Nat. Resour., Madison, WI 53711) MOVEMENT OF RAINBOW TROUT ACROSS A METALIMNION DEFICIENT IN DISSOLVED OXYGEN. Prog. Fish-Cult. 38 (1): 54. Jan. 1976. SFA 21(1).

After hypolimnetic aeration of dystrophic Larson Lake, Wisconsin, metalimnetic dissolved oxygen minima (less than 1 mg/l) were recorded in the middle to late summers of 1973 and 1974. One thousand rainbow trout were stocked on 4 September 1974: 500 (unmarked) on the surface and 500 (adipose fin clip) in the hypolimnion. Vertical gill netting a week later indicated that low dissolved oxygen concentrations in the metalimnion did not restrict trout movement through this zone.

76-000232 Stasko, A. B.; Horrall, R. M.; Hasler, A. E. (Fish. Mar. Serv., Biol. Stn., St. Andrews, NB E0G 2X0, Canada) COASTAL MOVEMENTS OF ADULT FRASER SOCKEYE SALMON (/ONCORHYNCHUS NERKA/) OBSERVED BY ULTRASONIC TRACKING. Trans. Am. Fish. Soc. 105 (1): 64-71. Jan. 1976. SFA 21(1).

Forty-three adult sockeye salmon (/Oncorhynchus nerka/) fitted with ultrasonic transmitters were tracked in coastal waters near the Fraser River in July and August, 1967 and 1968. Movement patterns of individual fish were unpredictable. Some moved actively in appropriate directions, some drifted passively, still others travelled southward

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away from their presumed destination. Fish released in pairs did not travel along similar paths. Active fish moved generally northward toward the Fraser River, keeping away from shore and following axes of tidal currents. There was little straying into bays and channels with slow currents. Some fish remained active both during the day and at night, while others became inactive after sunset or when the sun was not visible behind clouds. Average ground speed was about 1 body length/s (61 cm/s). Orientation to geoelectric fields is postulated, along with a compass-related orientation northward.

FOODS AND FEEDING

76-000233 Alevizon, W. S. (Dep. Biol. Sci., Fla. Inst. Tech., Melbourne 32901) COMPARATIVE FEEDING ECOLOGY OF A KELF-BED EMBIOTOCID (/EMBIOTOCA LATERALIS/). Copeia 1975 (4): 608-615. 31 Dec. 1975. SFA 21(1).

The diet and feeding morphology of the striped seaperch (/Embiotoca lateralis/) was studied in kelp-bed areas at Santa Cruz Island and the adjacent mainland off Santa Barbara, California. Fish from the island kelp-beds included more kinds of prey items in their diets and, in general, fed on larger prey items than did the mainland fish. Fish from the mainland contained much greater amounts of non-food material in the guts, indicating a more indiscriminate type of foraging behavior. Island fish had proportionately larger heads and mouths; however, several other morphological characters presumably unrelated to feeding ecology did not differ between the two populations. The differences in feeding ecology between mainland and island fish seem most likely attributable to differences in the density of food resources between the two areas.

76-000234 Baird, R. C.; Hopkins, T. L.; Wilson, D. F. (Dep. Mar. Sci., Univ. South Fla., St. Petersburg 33701) DIET AND FEEDING CHRONOLOGY OF /DIAPHIS TAANINGI/ (MYCTOPHIDAE) IN THE CARIACO TRENCH. Copeia 1975 (2): 356-365. 23 May 1975. SFA 21(1).

/Diaphus taaningi/, an abundant myctophid resident in the Cariacc Trench, Venezuela, undergoes a pronounced diurnal vertical migration between a daytime depth of 250 m and the upper 50 m at night. Gut analyses indicate that /D. taaningi/ feed primarily on herbivorous zooplankton; copepods and larvaceans constitute better than 70 percent of the total prey biomass and 97 percent of the total prey number. Prey items were small compared to fish length, with most items being less than 4 mm long. Certain morphological attributes of /D. taaningi/ were discussed in conjunction with diet. Fish taken between evening ascent and midnight contained many prey items while those taken prior to evening ascent were essentially empty. It appears that most of the feeding occurs early in the evening, with the remainder of the night being spent in digestion. Estimates of feeding rate and minimum prey density required to obtain the observed ration were 1.14 items/min and 154 items/m³, respectively. Several predictions concerning trophic organization in the Cariaco Trench are presented, together with a discussion of some ecological implications of the data.

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76-000235 Bulkley, R. V.; Spykermann, V. L.; Inmon, L. E. (Iowa Coop. Fish. Res. Unit, Iowa State Unit., Ames 50010) FOOD OF THE PELAGIC YOUNG OF WALLEYES AND FIVE COHABITING FISH SPECIES IN CLEAR LAKE, IOWA. Trans. Am. Fish. Soc. 105 (1): 77-83. Jan. 1976. SFA 21(1).

Food of the pelagic young of walleye (*Stizostedion vitreum vitreum*), yellow perch (*Perca flavescens*), yellow and white bass (*Morone* spp.), black and white crappies (*Pomoxis* spp.), spottail shiner (*Notropis hudsonius*), and carp (*Cyprinus carpio*) captured concurrently in tow-net hauls in 1972 was compared with zooplankton samples. Each fish species differed slightly in food selection. Selective feeding by cohabiting pelagic larvae might have been a contributing factor to the strong walleye year class produced.

76-000236 Confer, J. L.; Blades, P. I. (Dep. Biol., Ithaca Coll., Ithaca, NY 14850) OMNIVOROUS ZOOPLANKTON AND PLANKTIVOROUS FISH. Limnol. Oceanogr. 20 (4): 571-579. July 1975. SFA 21(1).

The distance at which *Lepomis gibbosus* reacts to zooplankton is shown to be a linear function of prey size. If fishes sweep out a cylindrical path as they forage the frequency of prey encountered is then proportional to the square of this reaction distance. With the inclusion of the probability of capture success after a fish pursues a prey, a model of prey selection can estimate the effect of predacious zooplankton on the energy ingestion of planktivorous fish. Since predacious zooplankton are much larger and more visible to the fish than their own prey, this more than compensates for the energy lost by the additional trophic level and the moderate ability of predacious zooplankton to elude capture.

76-000237 Craddock, E. R.; Blahm, T. H.; Parente, W. D. (NMFS, 2725 Montlake Blvd. East, Seattle, WA 98112) OCCURRENCE AND UTILIZATION OF ZOOPLANKTON BY JUVENILE CHINOOK SALMON IN THE LOWER COLUMBIA RIVER. Trans. Am. Fish. Soc. 105 (1): 72-76. Jan. 1976. SFA 21(1).

The stomachs of juvenile chinook salmon, *Oncorhynchus tshawytscha*, taken in the Prescott-Kalama area of the Columbia River during July-November 1968 and March-December 1969 were examined to obtain information on their contents. Zooplankton, especially *Daphnia*, were the major item in the diet of the young salmon from July through October, whereas insects were the most important constituents of the diet during spring and fall.

The zooplankton in the area was sampled from January 1968 to November 1969 and examined in relation to the relative abundance of juvenile chinook salmon and their stomach contents. *Daphnia*, *Bosmina*, and cyclopoid copepods were major zooplankters in the area, and their periods of highest abundance were associated with high water temperatures of summer. Samples taken during daylight hours indicated *Bosmina* were most numerous at the surface, *Daphnia* were most numerous below 5 m, and cyclopoid copepods were relatively uniform in their vertical distribution. The zooplankton populations were generally increasing during the season of juvenile chinook abundance (April-July). Juvenile chinook were selective in their feeding habits and consistently consumed *Daphnia* in a much higher percentage than it was found in the zooplankton samples.

76-000238 Dickie, L. M. (Dep. Oceanogr., Dalhousie Univ., Halifax, NS, Canada) PREDATION, YIELD, AND ECOLOGICAL EFFICIENCY IN AQUATIC FOOD CHAINS. J. Fish. Res. Board Can. 33 (2): 313-316. Feb. 1976. In English with French summ. SFA 21(1).

Given constancy of biomasses and sizes of predators and prey, the basic ecological equations are used to show that relative predation rates must increase rapidly as trophic level in aquatic food-chains drops towards primary production. The implications of this conclusion for exploitation at different food-chain levels is discussed.

76-000239 Elston, R.; Bachen, B. (N.Y. State Vet. Coll., Cornell Univ., Ithaca 14853) DIET FEEDING CYCLE AND SOME EFFECTS OF LIGHT ON FEEDING INTENSITY OF THE MISSISSIPPI SILVERSIDE, /MENIDIA AUDENS/, IN CLEAR LAKE, CALIFORNIA. Trans. Am. Fish. Soc. 105 (1): 84-88. Jan. 1976. SFA 21(1).

A study of the diet feeding cycle of 940 Mississippi silversides, /Menidia audens/ Hay, in two 24-hour sampling periods in Clear Lake, California, showed a predominance of crustacean zooplankton in the diet. /Ceriodaphnia/ sp., /Daphnia pulex/, and emerging dipterans were the most important food items. A pronounced morning feeding peak indicated visual feeding. Evidence of visual feeding is further given by statistically significant ingestion of larger food items at night and decreased feeding during the one moonless night. Occurrence of emerging midges in the diet during the second period indicates possible selective predation.

76-000240 Gannon, J. E. (Univ. Mich. Biol. Stn., Pellston 49769) THE EFFECTS OF DIFFERENTIAL DIGESTION RATES OF ZOOPLANKTON BY ALEWIFE, /ALOSA PSEUDOHARENGUS/, ON DETERMINATIONS OF SELECTIVE FEEDING. Trans. Am. Fish. Soc. 105 (1): 89-95. Jan. 1976. SFA 21(1).

Ivlev's electivity index (/E/) was used to assess selective feeding by the alewife (/Alosa pseudoharengus/) on crustacean zooplankton in southern Green Bay, Lake Michigan. Alewives positively selected larger species of Copepoda, especially /Mesocyclops edax/. Alewives appeared to negatively select all Caldocera. However, field data from Lake Michigan and other lakes containing abundant populations of alewives indicate positive selection may be occurring on /Daphnia/. Positive selection of /Daphnia/ by alewives probably took place in southern Green Bay, although this was not indicated in electivity indices. Laboratory studies revealed that /Daphnia/ were digested most rapidly by alewives and, therefore, were under-represented in stomach contents relative to other planktonic species. Consequently, it is suggested that differential digestion rates of prey organisms may also occur in alimentary tracts of other fish species. This could have an effect on interpretation of selective feeding data using Ivlev's electivity formula with other planktivorous fishes. The analysis of the composition of micro-crustacean cuticle as it relates to differential digestion of various planktonic species in fish stomachs is deserving of further research.

76-000241 Ginetz, R. M.; Larkin, P. A. (Fish. Mar. Serv., Vancouver, BC V6E 2N9, Canada) FACTORS AFFECTING RAINBOW TROUT (/SALMO GAIIRDNERI/) PREDATION ON MIGRANT FRY OF SOCKEYE SALMON (/ONCORHYNCHUS NERKA/). J. Fish. Res. Board Can. 33 (1): 19-24. Jan. 1976. In English with French summ. SFA 21(1).

Predation of rainbow trout (/Salmo gairdneri/) on migrant sockeye salmon (/Oncorhynchus nerka/) fry in experimental streams was higher on fry at an earlier development stage, in moonlight by contrast to cloudy night light intensities, at lesser turbidities, and at lower stream velocities. At dusk light intensities, from .05 to .30 ft-c,

76-000241 CONTINUED

mortality from predation was inversely related to light intensity. The longer the period of exposure of fry to naturally declining light intensities prior to downstream movement, the lower was the loss to predators. Exposure of predators to high light intensities prior to the downstream movement of fry resulted in decreased fry mortality. Fry that had survived exposure to predators in a experimental stream 1 and 2 days previous were less vulnerable to predation than "naive" fry. Successive exposures further decreased the loss to predation. Fry enumerated at a counting fence suffered less predation than fry not enumerated. Experienced fry moved downstream more rapidly than naive fry.

In laboratory aquaria, experienced fry formed compact schools prior to and in response to stimuli, while naive fry formed loose schools or did not school. Experienced fry were less active in responding to stimuli. Enumerated fry resembled experienced fry; nonenumerated fry resembled naive fry.

Various techniques on enhancing sockeye salmon fry survival during downstream migration are suggested by these results.

76-000242 Giussani, G.; Grimaldi, E. (Ist. Ital. Idrobiol., 28048 Pallanza, Italy) ANALOGIE E DIFFERENZE NEL REGIME ALIMENTARE DEI PESCI PLANKTOFAGHI DI QUATTRO GRANDI LAGHI TERMINALI TROPICAMENTE DIFFERENZIATI. [SIMILARITIES AND DIFFERENCES IN FEEDING HABITS OF PLANKTOPHAGOUS FISH IN FOUR LARGE LAKES WITH DIFFERENT TROPHIC CONDITIONS.] Mem. Ist. Ital. Idrobiol. 32: 349-363. 1975. In Italian with English summ. SFA 21(1).

Three planktophagous fish living in four large subalpine lakes of Northern Italy were studied in respect to their feeding habits. The results of this investigation are compared and discussed in relation to the different trophic conditions of the lakes.

76-000243 Heins, D. C.; Clemmer, G. H. (Dep. Biol., Tulane Univ., New Orleans, LA 70118) ECOLOGY, FOODS AND FEEDING OF THE LONGNOSE SHINER, /NCTROPIS LONGIROSTRIS/ (HAY), IN MISSISSIPPI. Am. Midl. Nat. 94 (2): 284-295. Oct. 1975. SFA 21(1).

/Notropis longirostris/ (Hay), the longnose shiner, was studied in the Jourdan River system, Hancock and Pearl River counties, Mississippi, from May 1970 through May 1972. Occurrence of /N. longirostris/ was significantly related to shore vegetation, bottom type, stream width, gradient and current. It was the most abundant species in stream sections characterized by large, open sandbars, clean, white, shifting sand bottoms, and a rapid fluctuation in flow rate and water depth. It occurred in the shallow areas along the edges of the sandbars where flow is low to moderate and the bank gradually slopes into the creek. /Ammocrypta beanii/ was most closely associated with /N. longirostris/ although /Notropis venustus/ was also commonly taken with the latter.

The dominant food items were dipteran larvae, emerging or newly emerged dipterans, and other aquatic insects. Changes in foods with season were noted. Larger fish consumed a greater variety of food items. There was marked periodicity in diel feeding activity in May 1971. Feeding was most intensive during morning and early afternoon hours.

76-000244 Lin, Y.-S. FOOD AND GROWTH OF YOUNG YELLOW PERCH DURING THE PELAGIC AND DEMERSAL STAGES IN ONEIDA LAKE. Ph. D. dissertation, Cornell Univ. 104p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(6), 1975. SFA 21(1).

The diet and growth of young yellow perch (*Perca flavescens*, Mitchell) at pelagic and demersal stages in Oneida Lake was compared with the abundance and vertical distribution of the limnetic zooplankton. Young perch were concentrated near the surface in early June and near bottom after July. Vertical transition occurred during a 1-2 week period in late June 1973 and late July 1972. Length distribution of perch during the transition period ranged from 38-47 mm in 1972 and 24-33 mm in 1973. Transition of perch from the pelagic to demersal stage occurred at a time when water temperatures were rising rapidly.

Seven species of Cladocera were observed in 1972, but only *Daphnia pulex* was found in 1973. In 1972 *D. retrocurva* and *L. galeata* were abundant in the surface water and *D. pulex* predominated near the bottom. In contrast, 1973 *D. pulex* were concentrated near the surface with lower densities in deep water. Vertical distribution of zooplankters did not play a significant role in determining the time of transition of perch to a demersal existence.

A diet of young perch showed marked difference between years and at different stages of development. During the pelagic stage they ate about equal numbers of Cladocera and copepods in 1972 and mostly *L. pulex* in 1973. During the vertical transition period perch contained mostly copepods. After they became demersal, *L. pulex* was the most important food in both years. Differences in food composition in 1972 and 1973 were attributable to difference in zooplankton composition and food selection. As yellow perch increased in size they fed on larger zooplankters in preference to smaller ones.

The growth rates of pelagic fry in 1972 and 1973 were approximately the same in spite of marked variation in composition and abundance of zooplankters in lake and perch stomachs. However, during the demersal stage perch grew more rapidly in 1973. Differences in size of daphnids in 1972 and 1973 probably contributed to differences in growth rate.

76-000245 Montgomery, W. L. (Dep. Zool., Ariz. State Univ., Tempe 85281) INTERSPECIFIC ASSOCIATIONS OF SEABASSES (SERRANIDAE) IN THE GULF OF CALIFORNIA. Copeia 1975 (4): 785-787. 31 Dec. 1975. SFA 21(1).

76-000246 Newsome, G. E. A STUDY OF PREY PREFERENCE AND SELECTION BY CREEK CHUB, *SEMOTILUS ATROMACULATUS*, IN THE MINK RIVER, MANITOWA. Ph.D. dissertation, Univ. Manitoba 1975. [Order microfiche copy from the National Library of Canada at Ottawa]. From Diss. Abstr. Int. B Sci. Eng. 36(9), 1976. SFA 21(1).

In the Mink River adult creek chub are selective feeders consuming mostly brook stickleback in early summer and crayfish in late summer despite the abundance of other species of potential prey. Johnny darters were the most highly preferred species of prey followed by cyprinids (pearl dace and common shiners), brook stickleback, and crayfish. Johnny darters were inaccessible to chub in the presence of a rocky substrate. The presence of vegetation reduced the accessibility of brook stickleback. The presence of the cyprinid fright pheromone although detectable by chub had no influence on the preference of chub for cyprinids and did not appear to affect the accessibility of cyprinids. An alternate mechanism controlling the accessibility of cyprinids is discussed.

76-000247 Possompes, E. P.; Bergot, P.; Luquet, F. (Lab. Nutr. Poissons, Cent. Natl. Rech. Zootech. I.N.R.A., 78350 Jcu en Josas, France) MISE AU POINT D'UNE METHODE D'ETUDE DU TRANSIT GASTRO-INTESTINAL CHEZ LA TRUITE ARC-EN-CIEL /SALMO GAIARDNERII/ RICHARDSON: INFLUENCE DU NOMBRE DE REPAS, DES QUANTITES INGEREES ET DE LA TEMPERATURE D'ACCLIMATATION. [DESCRIPTION OF THE METHOD OF GASTROINTESTINAL TRANSIT STUDY IN TROUT, /SALMO GAIARDNERII/ RICHARDSON. I.--INFLUENCE OF THE NUMBER OF MEALS, QUANTITIES INGESTED, AND TEMPERATURE OF ACCLIMATIZATION.] Ann. Hydrobiol. 6 (2): 131-143. 1975. In French with English summ. SFA 21(1).

The speed of digestion transit in trout is studied, establishing the kinetics of excretion of an indigestible marker (chromic oxide) incorporated in the food. The device which consists of a fractions collector, provided with filters and whose rotation is accomplished all the time, permitting to recover the faeces automatically.

This method is applied to study the influence of temperature on the transit rate of food, considering the effects of number of meals and quantities ingested.

After having clearly explained that 2 meals per day are sufficient for obtaining the satiety, it has been shown that:

The quantity of faeces emitted per unit of time is constant throughout 24 hours and it is proportional to the quantity ingested; the necessary time for the appearance of the maximum concentration of marker in faeces is independent of rhythm and volume of meals. However, this criteria of appraisal of rate of transit is more or less imprecisely judged; the mean retention time (Castle, 1956) and the mean transit time (Zierler, 1958) diminish when the number of meals increases; the mean transit time is independent of importance of meals; the mean transit time diminishes when the temperature of acclimatization of trout increases; it is 35 h at 9 C, 22.4 h at 14 C and 17 h at 18 C. (Auth. Summ.)

76-000248 Sadzikowski, M. R.; Wallace, D. C. (VPI & SU, Blacksburg, VA 24061) COMPARISON OF THE FOOD HABITS OF SIZE CLASSES OF THREE SUNFISHES (/LEPOMIS MACROCHIRUS/ RAFINESQUE, /L. GIBBOSUS/ (LINNAEUS) AND /L. CYANELLUS/ RAFINESQUE). Am. Midl. Nat. 95 (1): 220-225. Jan. 1976. SFA 21(1).

A study of the food habits of small (29-70 mm fork length), moderate (71-110 mm) and large (111-160 mm) sunfish species (/Lepomis macrochirus/ Rafinesque, /L. gibbosus/ (Linnaeus), /L. cyanellus/ Rafinesque) was based on specimens from the interconnected First and Second Sister lakes of Washtenaw Co., Michigan. The food of 166 /L. macrochirus/, 122 /L. gibbosus/ and 76 /L. cyanellus/ was compared. Throughout much of their life, plant material and ctenophores are important food sources for /L. macrochirus/ and /L. cyanellus/. Adult /L. gibbosus/ made much greater use of gastropods, and /L. cyanellus/ much less use of chironomids than did the other two species. The pharyngeal tooth morphology and mouth size of these species appear to be related to these differences in food habits.

76-000249 Saiki, M. K. (Univ. Ariz., Tucson 85721) MEAN BULK INDEX METHOD OF FISH FOOD ANALYSIS. Prog. Fish-Cult. 38 (1): 55-56. Jan. 1976. SFA 21(1).

Standard methods for quantifying the food of fish are laborious and time-consuming. The Mean Bulk Index is a method that provides a subjective, semiquantitative estimate of the volumetric importance of forage items, with relatively little effort. Management agencies involved with routine monitoring of fish food may find this method of particular value because it is suitable for food studies where precise measurements of number, volume, or biomass are not needed.

76-000250 Stauffer, J. R., Jr.; Wilson, J. H.; Lickson, K. L. (Univ. Md., Frostburg State Coll. Campus, Frostburg 21532) COMPARISON OF STOMACH CONTENTS AND CONDITION OF TWO CATFISH SPECIES LIVING AT AMBIENT TEMPERATURES AND IN A HEATED DISCHARGE. Prog. Fish-Cult. 38 (1): 33-35. Jan. 1976. SFA 21(1).

Stomach contents and condition of young-of-the-year of two catfish species (*Ictalurus punctatus* and *Pylodictus olivaris*) living at the highest ambient river temperature (26.7 C) and their final field temperature preference (34.4 C) in a heated discharge were compared.

Stomach contents of channel catfish captured at their preferred temperature differed from those of fish captured at ambient temperatures in the following ways: the number of taxa was reduced, the diversity index was lower, the total number of organisms was greater, the number of Chironomidae larvae increased, and the number of mayfly nymphs decreased. Stomach contents of flathead catfish captured at their preferred temperature differed from those of fish captured at reference temperatures in the following ways: the number of taxa was increased, the diversity did not differ, the total number of organisms was greater, the number of Chironomidae larvae increased, and the number of mayfly nymphs was not significantly different. Condition factors of both species were significantly ($P = 0.05$) lower in the heated discharge.

76-000251 Weaver, J. E. FOOD SELECTIVITY, FEEDING CHRONOLOGY, AND ENERGY TRANSFORMATIONS OF JUVENILE ALEWIFE (*Alosa pseudoharengus*) IN THE JAMES RIVER NEAR HOPEWELL, VIRGINIA. Ph.D. dissertation, Univ. Va. 98p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(7), 1975. SFA 21(1).

Juvenile alewife, *Alosa pseudoharengus* (Wilson), in the nursery area of the James River, Virginia usually exhibited a bimodal diurnal feeding periodicity. Mature calanoid and cyclopoid copepods, copepodite stages of copepods, and cladocerans were predominant prey during the day. Nocturnal feeding on ostracods, oligochates, and immature and mature insects was occasionally noted. In general, electivity (E) was strongly positive for the large adult copepods *Eurytemora affinis*, *Cyclops vernalis*, and the cladoceran *Leptodora kindtii*, moderately positive for the cladocerans *Bosmina* spp., neutral for copepodites, moderately negative for the cladoceran *Diaphanosoma brachyurum*, and strongly negative for copepod nauplii. The effects of selective predation on the zooplankton community were not as pronounced as those found in lake environments, although the relatively small *Bosmina* spp. increased in abundance during the period of maximum utilization of the nursery area by alosine fishes in both years.

Ash-free caloric value of fish biocontent, daily ration, egesta, assimilation, and respiration for an average fish increased from early summer through September in each year. Growth, as percent of assimilated energy, was 48 percent in 1972 and 37 percent in 1973 respectively. Mean maintenance efficiency was 52 percent in 1972 and 63 percent in 1973. Lower water temperatures in 1972 may partially account for these differences. (From Auth. Abstr.)

AGE AND GROWTH

76-000252 Benech, V. (Cent. O.R.S.T.O.M., B.P. 65, N'Djamena, Chad, Africa) NOTE SUR LA PREPARATION DES OTOLITHES, PLUS PARTICULIEREMENT DE CEUX DE L'ANGUILLE. [NOTE ON THE PREPARATION OF OTOLITHS, PARTICULARLY THOSE OF EEL.] Ann. Hydrobiol. 6 (2): 173-178. 1975. In French with English summ. SFA 21(1).

After a brief description of the various methods used for preparing fish otoliths, the author presents his own technique for the study of eel otoliths; it is based on the inclusion process, then grinding and coloration of the otolith. (Auth. Summ.)

76-000253 Bresnick, G. I. ENVIRONMENTAL EVALUATION BASED ON THE RELATIVE GROWTH RATES OF FISHES. Ph. D. dissertation, Tulane Univ. 78p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(8), 1976. SFA 21(1).

Physical and chemical water quality parameters and the relative growth rates of fishes were analyzed in a 19 km section of the Pearl River (Louisiana, Mississippi). Comparisons of the relative growth rates of blacktail shiner (*Notropis venustus*), silvery minnow (*Hybognathus nuchalis*), longear sunfish (*Lepomis megalotis*), and largemouth bass (*Micropterus salmoides*) were made between populations occupying clean water and populations occupying an area polluted by domestic sewage and kraft mill effluent. The mean back calculated standard length of age I blacktail shiner was significantly less in polluted than in clean water (3.09 cm versus 3.55 cm). Mean standard lengths of one and two year old silvery minnow were also depressed in the polluted area (2.68 cm versus 3.73 cm for age I individuals and 4.16 cm versus 5.19 cm for age II fish). No significant differences in growth were observed for longear sunfish or largemouth bass. Sixteen months after the initiation of secondary wastewater treatment by the kraft pulp and papermill growth analyses were repeated on the blacktail shiner and the silvery minnow. A significant increase (p less than 0.05) was found in the mean back calculated standard length of age I individuals occupying the polluted area. Analysis of the relative growth rates of fishes appears to be a sensitive method of environmental evaluation. Providing sufficient sampling is undertaken prior to and subsequent to the initiation of sophisticated wastewater treatment an analysis of the relative growth rates of fishes may prove extremely valuable for testing the effectiveness of treatment design. (From Auth. Abstr.)

76-000254 Brothers, E. B.; Mathews, C. P.; Lasker, R. (Langmuir Lab., Cornell Univ., Ithaca NY 14853) DAILY GROWTH INCREMENTS IN OTOLITHS FROM LARVAL AND ADULT FISHES. NOAA Fish. Bull. 74 (1): 1-8. Jan. 1976. SFA 21(1).

Daily growth increments have been found in otoliths of fish larvae. The daily nature of these layers was verified by examining larval fish of known age reared in the laboratory. A simple technique for observing these marks is described and can be used on otoliths from larvae and adults. This provides a convenient method for determining early growth in fishes and is particularly useful for fishes which do not lay down annual or seasonal rings.

SPORT FISHERY ABSTRACTS

76-000255 Eggleston, D. (Minist. Agric. Fish., Wellington, New Zealand) DETERMINATION OF AGE OF KAHAWAI /ARRIPIIS TRUTTA/ (BLOCH & SCHNEIDER). N. Z. J. Mar. Freshwater Res. 9 (3): 293-298. Sept. 1975. SFA 21(1).

Scales are unsuitable for age determination in /Arripis trutta/ older than 5 y (approximately equivalent to 40 cm L.C.F.). Otoliths can be used for fish of all ages. The maximum age recorded is 22 y.

76-000256 Moreau, J. (E.E.S.S.A., Univ. Madagascar, Tananarive, Madagascar) ESSAI D'INTERPRETATION DES ANNULI OBSERVES SUR LES ECAILLES DE /TILAPIA NILOTICA/ ET /TILAPIA RENDALLI/ DES LACS DES HAUTS PLATEAUX MALGACHES. II.--OBSERVATIONS SUR /TILAFIA RENDALLI/ AU LAC ALAOTRA. [INTERPRETATION TRIAL OF ANNULI OBSERVED ON SCALES OF /TILAPIA NILOTICA/ AND /T. RENDALLI/ OF THE LAKES OF MALAGASY HIGHLANDS. II. OBSERVATIONS ON /T. RENDALLI/ IN ALAOTRA LAKE.] Ann. Hydrobiol. 6 (2): 93-101. 1975. In French with English summ. SFA 21(1).

Ring formations are observed on scales of /T. rendalli/ in the Alaotra lake, on Malagasy Highlands, despite of a no distinct cold season. The suitability of using these rings for age determining methods is discussed. It is possible that the ring shows an annual growth stop during the time of low water mark. During this time indeed, /T. rendalli/ does not dispose enough of its chief food: aquatic weeds. (Auth. Summ.)

76-000257 Struhsaker, P.; Uchiyama, J. H. (NMFS, Honolulu Lab., Honolulu, HI 96812) AGE AND GROWTH OF THE NEHU, /STOLEPHORUS PURPUREUS/ (PISCES: ENGRAULIDAE), FROM THE HAWAIIAN ISLANDS AS INDICATED BY DAILY GROWTH INCREMENTS OF SAGITTAE. NOAA Fish. Bull. 74 (1): 9-17. Jan. 1976. SFA 21(1).

Direct evidence is presented that the sagittae of nehu, /Stolephorus purpureus/, grow by discernible daily increments. Aging by daily growth increments provides the means to establish a general growth curve for the first 6 mo of life for this species. Adult nehu exhibit nearly linear growth between 30 and 60 mm standard length. Preliminary evidence is presented that the nehu population of Pearl Harbor may grow more rapidly than that of Kaneohe Bay.

76-000258 Theiling, E. L.; Loyacano, H. A., Jr. (S. C. Wildl. Mar. Res. Dep., P.O. Box 12559, Charleston 29412) AGE AND GROWTH OF RED DRUM FROM A SALTWATER MARSH IMPOUNDMENT IN SOUTH CAROLINA. Trans. Am. Fish. Soc. 105 (1): 41-44. Jan. 1976. SFA 21(1).

Adult and juvenile red drum, /Sciaenops ocellata/ (Linnaeus), confined to a saltwater marsh impoundment at South Island, Georgetown County, South Carolina, were studied to determine their length-weight relationship, age according to otoliths, and the time of annulus formation in the otoliths. The equation $\log W = -1.29596 + 2.74031 \log L$ was determined for the relationship of length to weight. Sectioned otoliths revealed no annulus formed in fish up to 1,070 g and 38.5 cm in standard length, suggesting that no annulus was formed the first spring after hatching in September through November. Annuli were formed in spring (April-May). The largest fish belonged to the 1966 and 1967 year classes, which were in the marsh when the impoundment was formed in May 1968. Reading otoliths before they were cut produced erroneous results.

GEOGRAPHICAL DISTRIBUTION, FISH SURVEYS, ETC.

76-000259 Mearns, A. J. (South. Calif. Coastal Water Res. Proj., El Segundo 90245) SOUTHERN CALIFORNIA'S INSHORE DEMERSAL FISHES: DIVERSITY, DISTRIBUTION, AND DISEASE AS RESPONSES TO ENVIRONMENTAL QUALITY. Calif. Coop. Oceanic Fish. Invest. Rep. 17: 141-148. Oct. 1974. SFA 21(1).

76-000260 Austin, H. M. (NOAA, Rockville, MD 20852) DISTRIBUTION AND ABUNDANCE OF ICHTHYOPLANKTON IN THE NEW YORK BIGHT DURING THE FALL IN 1971. N. Y. Fish Game J. 23 (1): 58-72. Jan. 1976. SFA 21(1).

Sampling for phytoplankton, zooplankton, water chemistry and physical parameters was conducted at a series of stations in the New York Bight in September and November of 1971. The relationships of the finfish eggs and larvae collected to the associated oceanographic conditions are discussed in terms of the sources of the parent stocks and the time and place of spawning. The bulk of the spawning that occurs in coastal New York waters is by migratory stocks, the principal species in the New York Bight being the menhaden, anchovy, weakfish, mackerel and searobin.

76-000261 Berra, T. M.; Moore, R.; Reynolds, L. F. (Dep. Zool., Ohio State Univ., Mansfield 44906) THE FRESHWATER FISHES OF THE LALOKI RIVER SYSTEM OF NEW GUINEA. Copeia 1975 (2): 316-326. 23 May 1975. SFA 21(1).

At 22 collecting stations along the Laloki, Brown and Goldie Rivers a total of 43 native species belonging to 33 genera, 19 families and 7 orders was collected. Six exotic species (*Cyprinus carpio*, *Gambusia affinis*, *Poecilia reticulata*, *Tilapia mossambica*, *Trichogaster pectoralis*, *T. trichopterus*) were also taken. The lower reaches of the main channels contained the greatest number of species. Tributaries below Bouna Falls contained more species than similar tributaries above the falls. The most common native species were *Nematocentris sexlineatus*, *Melanotaenia goldiei*, *Hexanemichthys latirostris*, *Neosilurus bartoni*, *Tetracentrum apogonoides* and *Ophiocara porocephala*. The most abundant introduced species were *Tilapia mossambica* and *Gambusia affinis*. Eleven species newly reported for the Laloki System are listed and meristic and morphometric data were given for 12 common native species. The Laloki River fauna is compared to the north Australian fauna and shown to be closely related. About 50 percent of the Laloki River fishes are also found in Australia and about 50 percent are endemic to New Guinea. Water chemistry data are presented which show the Laloki River to contain soft water with little free CO₂, adequate dissolved oxygen and a pH of about 7.5.

76-000262 Borroni, I. (Ist. Ital. Idrobiol., 28048 Fallanza, Italy) PRESENZA DELLO SPINARELLO (*Gasterosteus aculeatus*) NEL BACINO DEL FIUME TOCE (PIEMONTE): STRUTTURA, CARATTERISTICHE DELLA CORAZZA CUTANEA ED ORIGINE DELLA POPOLAZIONE. [PRESENCE OF THE THREE-SPINED STICKLEBACK (*Gasterosteus aculeatus*) IN THE RIVER TOCE (PIEDMONT): STRUCTURE, CHARACTERISTICS OF THE BONY PLATES AND ORIGIN OF THE POPULATION.] Mem. Ist. Ital. Idrobiol. 32: 333-348. 1975. In Italian with English summ. SFA 21(1).

The three-spined stickleback (*Gasterosteus aculeatus*) has been found for the first time in North-Western Italy (Lake Maggiore catchment area).

SPORT FISHERY ABSTRACTS

76-000263 Casteel, R. W. (USGS, Menlo Park, CA 94025) AN EARLY POST-GLACIAL RECORD OF THE PACIFIC SARDINE /SARDINOPS SAGAX/, FROM SAANICH INLET, VANCOUVER ISLAND, BRITISH COLUMBIA) Copeia 1975 (3): 576-578. 5 Aug. 1975. SFA 21(1).

76-000264 Courtenay, W. R. Jr.; Sahlman, H. P.; Miley, W. W. II; Herrema, D. J. (Dep. Biol. Sci., Fla. Atl. Univ., Boca Raton 33432) EXOTIC FISHES IN FRESH AND BRACKISH WATERS OF FLORIDA. Biol. Conserv. 6 (4): 292-302. Oct. 1974. SFA 21(1).

At least 38 species and several hybrids of exotic fishes have been found in fresh and brackish waters of Florida. Twenty species and five hybrids are at present established in the form of reproducing populations. The ornamental aquarium fish industry has been the major source of these introductions. Several methods of introductions are considered and recommendations presented toward preventing repetitions in the future. Future dispersal of exotics by channelization projects should become part of environmental impact statements.

76-000265 Courtenay, W. R., Jr.; Miley, W. W. II (Dep. Biol. Sci., Fla. Atl. Univ., Boca Raton 33432) RANGE EXPANSION AND ENVIRONMENTAL IMPRESS OF THE INTRODUCED WALKING CATFISH IN THE UNITED STATES. Environ. Conserv. 2 (2): 145-148. 1975. SFA 21(1).

The Walking Catfish (/Clarias batrachus/), accidentally introduced into southeastern Florida in the mid-1960s, is currently distributed over more than 8,750 square km in ten counties of that State. The range of this exotic can reasonably be expected to extend over still further counties within the next few years. The present threat to fish farming interests, and the potential threat to native fishes, are thought to be serious. (Auth. Summ.)

76-000266 Courtenay, W. R., Jr. (Dep. Biol. Sci., Fla. Atl. Univ., Boca Raton 33432) STATUS OF INTRODUCED WALKING CATFISH IN FLORIDA. IUCN Bull. 6 (6): 23-24. June 1975. SFA 21(1).

76-000267 Cross, F. E.; Huggins, D. G. (Univ. Kans. Mus. Nat. Hist., Lawrence 66044) SKIPJACK HERRING, /ALOSA CHRYSOCHLORIS/, IN THE MISSOURI RIVER BASIN. Copeia 1975 (2): 382-385. 23 May 1975. SFA 21(1).

76-000268 Echelle, A. A.; Schnell, G. D. (Biol. Dep., Baylor Univ., Waco, TX 76706) FACTOR ANALYSIS OF SPECIES ASSOCIATIONS AMONG FISHES OF THE KIAMICHI RIVER, OKLAHOMA. Trans. Am. Fish. Soc. 105 (1): 17-31. Jan. 1976. SFA 21(1).

Species associations among 48 fish species of the Kiamichi River, a large tributary of Red River in SE Oklahoma, were examined using factor analysis of abundance data for 131 collection localities. Collections with high scores for Factors II and III (Steelcolor Shiner and Brook Silverside Groups) were concentrated in upper portions of the drainage, although certain species of both groups were rather widely distributed over the drainage. Collections with high scores for Factor I (White Bass Group) were primarily restricted to the mainstream of the lower Kiamichi River; those with high scores for Factors V and VI (Silvery Minnow and Golden Shiner Groups) were concentrated in tributaries of the lower Kiamichi. Excepting two species restricted to the lower Kiamichi, the species of Factor IV (Green Sunfish Group) were widely distributed over the drainage. In general, occurrence in the lower Kiamichi was positively correlated

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with westward distribution of the species into prairie environments of Oklahoma. Apparently, this was due to the ability of many of these species to thrive in lentic waters and/or to their ecological flexibility. Brief consideration is given to factors influencing distributions of species and to possible impacts of reservoir construction on the ichthyofauna of the Kiamichi River.

76-000269 Jenkins, R. E.; Burkhead, N. M. (Dep. Biol., Salem Coll., Salem, VA 24153) RECENT CAPTURE AND ANALYSIS OF THE SHARPHEAD DARTER, /*THEOSTOMA ACUTICEPS*/, AN ENDANGERED PERCID FISH OF THE UPPER TENNESSEE RIVER DRAINAGE. Copeia 1975 (4): 731-740. 31 Dec. 1975. SFA 21(1).

The sharphead darter, /*Etheostoma* (Nothonotus) *acuticeps*/, was known from 34 specimens taken during 1930-1949 from South Fork Holston River, Tennessee and North Toe River, North Carolina, both upper Tennessee River drainage. Alteration of swift water habitat by siltation, other forms of pollution and impoundment evoked suggestions that /*E. acuticeps*/ was endangered or extinct. Three specimens were collected in the South Fork Holston, Virginia in 1972, but the continued existence of the species remains questionable. It should be regarded as rare, endangered and nearly extinct. Habitat and certain aspects of life history of /*E. acuticeps*/ are similar to those of one or more syntopic members of /*Nothonotus*/. The recently collected specimens agree with previously described ones in morphology and coloration.

76-000270 Johnson, W. S.; Mace, J. T.; Turner, A. S. (New Zealand Minist. Agric. Fish., Christchurch, New Zealand) FISHERIES SURVEY OF LAKE CHRISTABEL, WEST COAST ACCLIMATISATION DISTRICT, SOUTH ISLAND. N. Z. Minist. Agric. Fish. Fish. Tech. Rep. No 144. 28p. 1976. SFA 21(1).

Findings of a brief survey of Lake Christabel, West Coast, South Island, New Zealand, are described. Lake Christabel is a glacial lake (area 270 hectares, 647 metres above sea level) situated amidst dense native rain forest in mountainous country. Results of limnological and biological sampling are presented. These disclosed only native flora and fauna, i.e. exotic species such as salmonids were lacking. Although the lake has some potential for the development of a salmonid fishery, it was concluded that its greatest value is in its natural state and therefore no introductions of plants or animals should be made into it.

76-000271 Kami, H. T. (Div. Fish Wildl., Dep. Agric., Agana, Guam 96910) CHECK-LIST OF GUAM FISHES, SUPPLEMENT II. Micronesica 11 (1): 115-121. 1975. SFA 21(1).

76-000272 Masnik, M. T. COMPOSITION, LONGITUDINAL DISTRIBUTION, AND ZOOGEOGRAPHY OF THE FISH FAUNA OF THE UPPER CLINCH SYSTEM IN TENNESSEE AND VIRGINIA. Ph.D. dissertation, Va. Polytech. Inst. & State Univ. 418p. 1975. From Diss. Abstr. Int. B Sci. Eng. 35(10), 1975. SFA 21(1).

The Clinch system is one of the major upper tributaries to the Tennessee River. It possesses one of the most diverse fish faunas in North America. Recent fish kills, one catastrophic, in the main channel Clinch River and in an upper tributary encouraged the author to begin his study of the ichthyofauna.

A total of 457 collections (approximately 132,000 specimens) from the upper Clinch system above Norris Reservoir revealed a total of 104 species (about 95 native) of which four are possibly extirpated from

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the system.

An annotated list of species was prepared giving the ranges, where applicable, for the physical parameters altitude, gradient, and stream order. Also comments on the systematics, intrasystem distribution, occurrence in Norris Reservoir and lower Clinch River tributaries, and field observations on habitat preferences and life history for each species was listed. A dichotomous key and spot distribution maps accompany the annotated list.

Zoogeographical evidence suggests that the majority of the fauna have an autochthonous origin within the lower Mississippi basin.

The relative importance of the three physical parameters; altitude, gradient, and stream order, in determining the number of taxa, population size, and diversity for 166 collections located on the upper Clinch system is discussed. Evidence suggests that faunal assemblages can be best characterized by stream order since stream order reflects a composite of known parameters influencing fish distribution.

The longitudinal distributional pattern of fishes was largely addition of species, rather than replacement, progressing downstream (increasing stream order).

New records for taxa for the upper Clinch system include /*Ichthyomyzon greeleyi*/, /*Hybognathus hankinsoni*/, /*Noturus*/ sp. (*pygmy madtom*), and /*Cottus bairdi*/ subsp. (broadband sculpin).

Counts and measurements for Clinch populations of /*Ichthyomyzon bdellium*/, /*I. greeleyi*/, /*Clinostomus f. funduloides*/, /*Cottus c. carolinae*/, and /*C. bairdi*/ subsp. are given. (From Auth. Abstr.)

76-000273 Matsumoto, W. M. (NMFS Honolulu Lab., Honolulu, HI 96812) SECOND RECORD OF BLACK SKIPJACK, /*EUTHYNNUS LINEATUS*/, FROM THE HAWAIIAN ISLANDS. NOAA Fish. Bull. 74 (1): 207. Jan. 1976. SFA 21(1).

76-000274 McDowall, R. M.; Hopkins, C. L.; Flain, M. (New Zealand Minist. Agric. Fish., Wellington, New Zealand) FISHES. N. Z. Minist. Agric. Fish. Fish. Res. Publ. No. 240. 15p. 1975. SFA 21(1).

Discusses the fishes of New Zealand. (RS)

76-000275 Novacek, M. J.; Marshall, L. G. (Dep. Paleontology, Univ. Calif., Berkeley 94720) EARLY BIOGEOGRAPHIC HISTORY OF OSTARIOPHYSAN FISHES. Copeia 1976 (1): 1-12. 12 Mar. 1976. SFA 21(1).

A theory is proposed for the early biogeographic history of ostariophysan fishes that incorporates: 1) the most recent data on geographic and geologic distribution of ostariophysans, 2) plate tectonic theory, 3) a phylogenetic hypothesis, including a consideration of Hennig-Brundin concepts of phylogenetic biogeography. The evidence suggests only three possible centers of origin for ostariophysans: 1) Africa, 2) South America or 3) Gondwana. If the origin of ostariophysans was a post-Jurassic event, then South America is the most likely center of origin for the group. We postulate that ostariophysans originated in South America in the earliest Cretaceous and there split into two sister groups, the Cypriniformes and Siluriformes. These groups dispersed throughout South America and the adjoining west shield area of Africa by middle Cretaceous. After regression of the west African epicontinental sea and rifting apart of west Africa and South America in the late Cretaceous, characoids and siluriforms dispersed throughout Africa. In South America and Africa these groups underwent independent adaptive radiations.

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76-000276 Robertson, L. A. (Minist. Agric. Fish., Wellington, New Zealand) /DIPLOPHOS REBAINSI/ KREFFT & PARIN, 1972, AN ADDITION TO THE MESOPELAGIC FISH FAUNA OF NEW ZEALAND. N. Z. J. Mar. Freshwater Res. 9 (3): 411-415. Sept. 1975. SFA 21(1).

Plankton samples taken in the south-western Pacific Ocean and the Tasman Sea have provided, for the first time in these waters, a series of individuals of the gonostomatid /Diplophos rebaini/. Observations are presented on some of the prejuvenile and adult features and on the seasonal distribution of prejuveniles off New Zealand.

76-000277 Robertson, D. A. (Minist. Agric. Fish., Wellington, New Zealand) PLANKTONIC STAGES OF THE TELEOST FAMILY CARAPIDAE IN EASTERN NEW ZEALAND WATERS. N. Z. J. Mar. Freshwater Res. 9 (3): 403-409. Sept. 1975. SFA 21(1).

The occurrence of planktonic carapid eggs in Otago waters, of young stages of /Echiodon rendahli/ off Castlepoint, and the possible presence of unrecorded members of the family Carapidae in New Zealand waters is discussed. Young /E. rendahli/ possess a long spine which originates dorsally to a distinctive suspended gut.

76-000278 Senta, T.; Min, T. S. (Southeast Asia Fish. Develop. Cent., Changi Point, Singapore-17) CATALOGUE OF THE FISHES FROM THE SOUTH CHINA SEA AND ANJAMAN SEA. Southeast Asian Fish. Develop. Cent., Singapore 32p. Dec. 1975. SFA 21(1).

76-000279 Sonnier, P.; Teerling, J.; Hoes, H. D. (102 Oak Glen Cr., Lafayette, LA 70501) OBSERVATIONS ON THE OFFSHORE REEF AND PLATFORM FISH FAUNA OF LOUISIANA. Copeia 1976 (1): 105-111. 12 Mar. 1976. SFA 21(1).

Observations, photographs and collections of fishes on the western reefs of the outer Louisiana continental shelf and around oil platforms have verified the presence of an extensive tropical fish fauna. Of 105 species recorded, about 50 percent were tropical species either unreported or rarely reported from the northwestern Gulf of Mexico. Reefs contained more species than oil platforms, although a number were common to both, and 12 species were found only around platforms. The 67 species of fishes found at the deeper reefs were all typical Caribbean-West Indian forms.

76-000280 Teller, S.; Bardack, D. (Dep. Biol. Sci., Univ. Ill., Chicago 60680) NEW RECORDS OF LATE PLEISTOCENE VERTEBRATES FROM THE SOUTHERN END OF LAKE MICHIGAN. Am. Midl. Nat. 94 (1): 179-189. July 1975. SFA 21(1).

Late Pleistocene vertebrates from LaPorte Co., Indiana, are identified and discussed. Genera from the site include the fishes, /Lepiosteus/, /Esox/, /Ictalurus/, /Lepomis/, /Micropterus/, /Stizostedion/; a turtle, /Chrysemys/, and a bird, /Gavia/. The fossils occur in beds more than 5500 but less than 6300 years old. Geological and ecological evidence suggests that the fossils were deposited in a shallow lake or pond with a muddy bottom and weedy vegetation. Other Pleistocene vertebrate records from the Great Lakes drainage are discussed.

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76-000281 Wilk, S. J.; Silverman, M. J. (NMFS, Sandy Hook Lab., Highlands, NJ 07732) FISH AND HYDROGRAPHIC COLLECTIONS MADE BY THE RESEARCH VESSELS /DOLPHIN/ AND /DELAWARE II/ DURING 1968-72 FROM NEW YORK TO FLORIDA. NOAA Tech. Rep. NMFS SSRF-697. iii + 159p. Jan. 1976. SFA 21(1).

Information is given in tabular form for fish and hydrographic observations collected during 18 cruises made by the research vessels /Dolphin/ and /Delaware II/ from New York to Florida during 1968-72. Tables include station locations with related hydrographic observations and number, weight, and size range of fish species caught.

76-000282 Wilk, S. J.; Silverman, M. J. (NMFS, Sandy Hook Lab., Highlands, NJ 07732) SUMMER BENTHIC FISH FAUNA OF SANDY HOOK BAY, NEW JERSEY. NOAA Tech. Rep. NMFS SSRF-698. iv + 16p. Jan. 1976. SFA 21(1).

Thirty-eight species and 25 families of fishes were captured during an otter trawl survey in Sandy Hook Bay, N.J., during July to October 1970. Distribution, abundance, length and age composition, and environmental preferences were analyzed for the more numerous species. Winter flounder, /Pseudopleuronectes americanus/; striped searobin, /Prionotus evolans/; windowpane, /Scophthalmus aquosus/; and northern searobin, /Prionotus carolinus/, accounted for 68.3 percent by number and 66.4 percent by weight of the total survey catch.

76-000283 Williams, J. C. (Dep. Biol. Sci., East. Ky. Univ., Richmond 40475) COMMERCIAL FISHERY INVESTIGATIONS OF THE KENTUCKY RIVER. PART I: FISH POPULATION STUDIES AND MUSSEL BED SURVEYS. Ky. Dep. Fish Wildl. Resour. Proj. No. 2-186-R, Jobs 1 & 2. iv + 64p. Jan. 1975. SFA 21(1).

Part I of Project 2-186-R contains Job 1, Fish Population Studies of the Kentucky River and Job 2, Mussel Bed Surveys of the Kentucky River. The 1972 and 1973 studies of commercial fishes did not vary significantly with the results of Carter's 1951 study. In all the three studies, carp were predominant in poundage and drum for numbers of individual species. Forage fishes appeared to vary considerably from year to year, depending upon spawning success. Only three mussel beds in the river are large enough to be considered commercially valuable and they are relatively small in size. Recruitment of young mussels is marginal and probably not great enough to replenish the beds if commercial musseling reduced the present numbers. Increased silt load due primarily to strip and auger mining in the headwater region appears to be the primary factor affecting spawning success of finfishes and recruitment of young mussels in the beds.

76-000284 Zawacki, C. S.; Briggs, P. T. (N. Y. State Dep. Environ. Conserv., 50 Wolf Rd., Albany 12201) FISH INVESTIGATIONS IN LONG ISLAND SOUND AT A NUCLEAR POWER STATION SITE AT SHOREHAM, NEW YORK. N. Y. Fish Game J. 23 (1): 34-50. Jan. 1976. SFA 21(1).

The shore-zone waters near a nuclear power station site on Long Island Sound at Shoreham (N.Y.) serve seasonally as a nursery ground for several species of fish, particularly the Atlantic silverside and Atlantic menhaden. The Near-shore waters are important summer grounds for scup and juvenile bluefish. Chlorinated hydrocarbon and trace metal concentrations were determined in migratory (striped bass and juvenile bluefish) and resident (windowpane) fishes caught in the area and were found to be low.

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ABUNDANCE, FACTORS OF; SURVIVAL AND MORTALITY

76-000285 Burnet, A. M. R.; Wallace, D. A. (New Zealand Minist. Agric. Fish., Wellington, New Zealand) EUTROPHICATION AND THE TROUT ENVIRONMENT. N. Z. Minist. Agric. Fish. Fish. Res. Publ. No. 241. 6p. 1975. SFA 21(1).

We consider that there is need for further investigation of the direct and indirect effects of eutrophication on trout fisheries and for a wider coverage in the documentation of the present trophic levels of our waters. This information, together with studies on the relation to nutrient levels and the identification of limiting nutrients, is necessary to establish standards for nutrient levels so that we can protect our lakes and fisheries from eutrophication. (Auth. Concl.)

76-000286 Clady, M. D. (Dep. Nat. Resour., Cornell Univ., Ithaca, NY 14850) CHANGE IN ABUNDANCE OF INSHORE FISHES IN ONEIDA LAKE, 1916 TO 1970. N. Y. Fish Game J. 23 (1): 73-81. Jan. 1976. SFA 21(1).

The frequency of occurrence of 57 species of fish captured by seining in the littoral zone in Oneida Lake in 1916-1927 was compared with similar data for 1960-1970. The incidence of eight species--chain pickerel, silvery minnow, spottail shiner, bridge shiner, bigmouth shiner, yellow bullhead, trout-perch and Iowa darter--decreased significantly, probably due to shoreline development and subtle eutrophication. The incidence of the bluegill and white perch increased, with the latter being the only exotic species to become well established between 1916 and 1970. The populations of large percids and centrarchids--the important recreational species--apparently did not change significantly.

76-000287 Pollett, W. I.; Ainley, D. G. (Calif. Acad. Sci., San Francisco 94118) FISHES COLLECTED BY PIGEON GUILLEMOTS, /CEPPHUS COLUMBA/ (FALLAS), NESTING ON SOUTHEAST FARALLON ISLAND, CALIFORNIA. Calif. Fish Game 62 (1): 28-31. Jan. 1976. SFA 21(1).

Twenty-four species of marine fishes obtained from nests of pigeon guillemots (/Cepphus columba/) during 1971-1974 on Southeast Farallon Island, California, increase to 42 the number of species of fishes known as prey of pigeon guillemots. Five species are rare: the rockhead (/Bothragonus swanii/), frogmouth sculpin (/Icelinus oculatus/), darter sculpin (/Radulinus boleoides/), an undescribed bathymasterid, and an undescribed cecidichthyid. Sculpins (Cottidae/), constituting 52 percent of the material, indicate that pigeon guillemots forage within the benthic environment; one species has been recorded off California only between depths of 170 and 220 m (93 and 124 fm).

76-000288 MacCall, A. (Calif. Dep. Fish Game, 350 Golden Shore, Long Beach 90802) THE MORTALITY RATE OF /ENGRAULIS MORDAX/ IN SOUTHERN CALIFORNIA. Calif. Coop. Oceanic Fish. Invest. Rep. 17: 131-135. Oct. 1974. SFA 21(1).

The annual mortality rate for the northern anchovy, /Engraulis mordax/, is estimated to be 66.5 percent in southern California waters, although the mortality rate increases sharply for older fish. A method for evaluating recruitment regularity and age constancy of mortality is presented.

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76-000289 Richards, J. S. (Psychol. Dep., Kent State Univ., Kent, OH 44240) CHANGES IN FISH SPECIES COMPOSITION IN THE AU SABLE RIVER, MICHIGAN FROM THE 1920'S TO 1972. Trans. Am. Fish. Soc. 105 (1): 32-40. Jan. 1976. SFA 21(1).

Fish collections taken in the 1920's from the Au Sable River, Michigan, were replicated in 1972. The Au Sable system as a whole has remained a non-rigorous, predictable environment for fish species. Substantial changes in fish species lists have occurred at most stations. The percentage of cold-water species present in the cold-water, moderate flow areas has increased, while species diversity, evenness, and numbers of species have remained constant. The warm headwater areas remain unchanged. Below the impoundments and in the large river areas, water quality has changed with subsequent reductions in species diversity and evenness, and large changes in species lists.

IDENTIFICATION, KEYS, CLASSIFICATION

76-000290 Anderson, W. D., Jr.; McKinney, J. P.; Roumillat, W. A. (Grice Mar. Biol. Lab., Coll. of Charleston, 205 Fort Johnson, Charleston, SC 29412) REVIEW OF THE SCORPAENID GENUS /IDIASTION/. Copeia 1975 (4): 780-782. 31 Dec. 1975. SFA 21(1).

76-000291 Anderson, W. D., Jr.; Smith-Vaniz, W. P. (Grice Mar. Biol. Lab., Coll. Charleston, 205 Fort Johnson, Charleston, SC 29412) SEXUAL DIMORPHISM IN THE JAWFISH /OPISTOGNATHUS MELACHASNE/. Copeia 1976 (1): 202-204. 12 Mar. 1976. SFA 21(1).

76-000292 Andreasen, J. K. SYSTEMATICS AND STATUS OF THE FAMILY CATOSTOMIDAE IN SOUTHERN OREGON. Ph.D. dissertation, Oreg. State Univ. 84p. 1976. From Diss. Abstr. Int. B Sci. Eng. 36(7), 1976. SFA 21(1).

This study was undertaken to clarify the systematic relationships and to determine characters useful in identifying the catostomids of southern Oregon. The nature and extent of hybridization between the species in Upper Klamath Lake was investigated and the population status of the species was determined.

The characteristics most useful in identifying the species are the number of gill rakers, head length, the number of lateral line scales, characteristics of the lips and head depth. /Chasmistes/ have large numbers of long gill rakers, a terminal mouth with smooth reduced lips, a wide median notch separating the lobes of the lower lip and a series of osteological changes associated with movement of the mouth to a terminal position. /Catostomus/, except for /C. luxatus/, have inferior mouths with large fleshy lips; the lobes of the lower lip meet at the mid-line. In /C. luxatus/ the lower lip is separated by a wide notch and the lips are covered with coarse papillae.

Some hybridization has occurred in Upper Klamath Lake between /Catostomus snyderi/ and /C. luxatus/, and between /C. snyderi/ and /Chasmistes brevirostris/, but introgression has not occurred and distinct species are still present. Extensive hybridization and introgression between /C. snyderi/ and /Chasmistes brevirostris/ has taken place in the Lost River, and /brevirostris/ no longer exists there as a distinct species. Few /C. luxatus/ were collected in the Lost River.

A unique species, /Chasmistes stomias/, was extirpated from Lake of the Woods, Oregon, by fish control operations in 1952.

Examination of historical data, field collections and creel census

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data all support the conclusion that */Chasmistes brevirostris/* and */Catostomus warnerensis/* should receive an endangered species status under the criteria of the Endangered Species Act of 1973.

Much of the decline in sucker numbers has been caused by the loss of spawning habitat due to the construction of irrigation diversion dams. To prevent further reduction in the abundance of these unique species, steps must be taken to restore access to adequate spawning habitat. (From Auth. Abstr.)

76-000293 Butler, J. L.; Ahlstrom, E. H. (NMFS, La Jolla Lab., La Jolla, CA 92038) REVIEW OF THE DEEP-SEA FISH GENUS */SCOPELENGYS/* (NEOSCOPELIDAE) WITH A DESCRIPTION OF A NEW SPECIES, */SCOPELENGYS CLARKEI/*, FROM THE CENTRAL PACIFIC. NOAA Fish. Bull. 74 (1): 142-150. Jan. 1976. SFA 21(1).

/Scopelengys/ has been known previously from a few widely scattered collections. Recent collections by the Scripps Institution of Oceanography in the Pacific, the RV */Walther Herwig/* in the Atlantic, and the International Indian Ocean Expedition have made possible a critical study of this genus. No significant differences were found in either morphometric characters or meristic counts between specimens of */S. tristis/* Alcock from the eastern North Pacific (lat. 16 to 33 N, long. 117 to 126 W) and those from the eastern South Pacific (lat. 5 to 16 S, long. 17 to 90 W). When Pacific Ocean specimens were compared with those from the Atlantic and Indian oceans, no significant differences were found in morphometric characters, and although differences in average meristic counts were somewhat larger between oceans than among Pacific specimens, such differences exceed one for only one meristic character (gill rakers), and the ranges for all counts from all oceans almost completely overlapped.

/Scopelengys clarkiei/ is described from the central North Pacific. It differs from */S. tristis/* mainly in pectoral ray count (2.5 average difference), average counts of vertebrae (3.3 average difference), deeper caudal peduncle, narrower maxillary, and in a differently pigmented larva.

76-000294 Cashner, R. C. A SYSTEMATIC STUDY OF THE GENUS */AMBLOPLITES/*, WITH COMPARISONS TO OTHER MEMBERS OF THE TRIBE AMBLOPLITINI (PISCES: CENTRARCHIDAE). Ph.D. dissertation, Tulane Univ. 384p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(12), 1975. SFA 21(1).

A systematic study of the genus */Ambloplites/*, tribe Ambloplitini, was made using specimens from throughout its range in eastern North America. Based on data gathered, a new species from the Ozark Upland section of the White River in Arkansas and Missouri was described, and the nimal subspecies */Ambloplites rupestris arionmus/* and */A. r. rupestris/* were elevated to specific rank. A survey of the federal and state stocking programs was made in an attempt to determine the effects of introduction on the natural distribution patterns of the different forms. Geographic variation was also studied in the other two members of the tribe, */Archoplites interruptus/* and */Acantharchus pomotis/*.

Generic comparisons were made for all three genera in the tribe and for all members of the subfamily Centrarchinae, and */Lepomis/* and */Chaenobryttus/* of the subfamily Lepominae. Data from this study supported the resurrection of the genus */Chaenobryttus/* by Smith and Lundberg (1971). The members of the tribe Ambloplitini were found to be the least similar morphologically of the superspecific groups in the Centrarchidae, with */Acantharchus/* being the most divergent member. Relationships of all species, possible dispersal routes, and alternative taxonomic views were discussed.

76-000295 Contrearras-Balderas, S. ZOOGEOGRAPHY AND EVOLUTION OF /NOTROPIS LUTRENSIS/ AND /"NOTROPIS" ORNATUS/ IN THE RIO GRANDE BASIN AND RANGE, MEXICO AND UNITED STATES (PISCES: CYPRINIDAE). Ph.D. dissertation, Tulane Univ. 156p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(8), 1976. SFA 21(1).

The complexes of /Notropis lutrensis/ and /"Notropis" ornatus/ in the Rio Grande Basin and Range are revised. /N. lutrensis/ inhabits most of the former parts of the Pluvial Rio Grande, and had differentiated in seven subspecies and eight races, grouped in two lines of evolution; for each such line the term subspecies group is herein used. The /lutrensis/ subspecies group is composed of four subspecies: /N. l. lutrensis/ in the Rio Grande River (except the Rio Conchos) and in the Rio San Fernando; /N. lutrensis/ ssp. in the Rio Conchos; /N. l. garmani/ in the Rio Nazas and the Rio Aguanaval; and /N. l. forlonensis/ in Rio Panuco and Rio Temesi; /N. lutrensis:/ /lutrensis/ X /Forlonensis/ intergrades inhabit the Rio Soto la Marina. The /formosus/ subspecies group is composed of the following three subspecies: /N. l. formosus/ with races in the Rio Casas Grandes, Rio Santa Clara, and Rio Yaqui (a North and a South race); /N. lutrensis/ ssp. in the Rio Sauz, and /N. l. santamariae/ in the Rio Santa Maria. The view held is that differentiation in this species has been the result of the drying up of Pluvial Rio Grande to a point where the upper tributaries were isolated, and some stream captures helped in the fragmentation of the basin. Since most of the rivers are desert streams, seasonally intermittent, and mostly dry during the dry season, the survivors that make up the next generation are subject to rapid genetic drift, although extreme selection pressures continue to be an alternative hypothesis. North and east to the Mississippi Basin, /N. lutrensis/ is not known to be so differentiated. The generic status of /"Notropis" ornatus/ is undetermined at this time. Morphologically it resembles the genus /Pimephales/. Studies are in progress to clarify the generic relationship and status of this form, which has been regarded as a valid genus, /Codoma/. (From Auth. Abstr.)

76-000296 Dawson, C. E. (Gulf Coast Res. Mus., Ocean Springs, MS 39564) STUDIES ON EASTERN PACIFIC SAND STARGAZERS 3. /DACTYLAGNUS/ AND /MYXODAGNUS/, WITH DESCRIPTION OF A NEW SPECIES AND SUBSPECIES. Copeia 1976 (1): 13-43. 12 Mar. 1976. SFA 21(1).

The dactyloscopid genera /Dactylagnus/ and /Myxodagnus/ are diagnosed and described and a key is provided for the six species and subspecies recognized from eastern Pacific waters. /Dactylagnus/ is represented by /D. mundus/ Gill (Baja California peninsula, Gulf of California and south to Panama) and by /D. parvus/ n. sp. from Baja California Sur and Navarrit, Mexico and El Salvador, Nicaragua and Panama. /Myxodagnus/ is represented by /M. o. opercularis/ Gill, /M. o. walkeri/ n. ssp., /M. sagitta/ Myers and Wade and /M. macrognathus/ Hildebrand. /M. o. opercularis/ ranges from Punta Hughes (about 24° 45'N) on the Pacific coast of Baja California around Cape San Lucas to Bahia San Luis Gonzaga (about 29° 45'N) in the western Gulf of California and in the eastern Gulf from Puerto Penasco south to Guaymas, in the Mexican state of Sonora. /M. o. walkeri/ is a small species known only from Nayarit, Mexico and Golfo de Nicoya, Costa Rica and /M. sagitta/ is a Galapagos Islands endemic. /M. macrognathus/ is known from Sinaloa to Oaxaca, Mexico and from Isla Lobos de Tierra, Peru. These isolated populations, together with that in Islas Revillagigedos (provisionally referred to /M. o. opercularis/), may warrant subspecific status when adequate study material becomes available. The almost complete absence of /Myxodagnus/ from mainland coasts between Oaxaca, Mexico and Peru is anomalous (compared with that of other sand stargazers) and remains

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unexplained. Illustrations and distribution maps are provided for each species.

76-000297 Ebeling, A. W. (Dep. Biol. Sci. Mar. Sci. Inst., Univ. Calif., Santa Barbara 93106) A NEW INDO-PACIFIC BATHYPELAGIC-FISH SPECIES OF /POROMITRA/ AND A KEY TO THE GENUS. Copeia 1975 (2): 306-315. 23 May 1975. SFA 21(1).

A new bathypelagic fish of the melamphaid genus /Poromitra/ is described from representative samples of specimens from the tropical Indowestern Pacific and eastern Pacific areas. Most of its distinctive characters, such as its tiny eye, regressed swimbladder and the reduced or delicate condition of its bony elements may reflect adaptations to its relatively deep habitat. The surprisingly scant morphological variation which shows between the two broad areas is discussed relative to its water-mass distribution and those of more shallow-living species. The new species and its 3 congeners are distinguished in an annotated key.

76-000298 Fahay, M. P. (NMFS, Sandy Hook Lab., Highlands, NJ 07732) /PARAXENOMYSTAX/ SP., A MURAENOSCID LEPTOCEPHALUS, IN THE WESTERN NORTH ATLANTIC. Copeia 1976 (1): 210-211. 12 Mar. 1976. SFA 21(1).

76-000299 Garrick, J. A. P.; Paul, L. J. (Zool. Dep., Victoria Univ., Wellington, New Zealand) THE TAXONOMY OF NEW ZEALAND SKATES (SUBORDER RAJOIDEA), WITH DESCRIPTIONS OF THREE NEW SPECIES. J. R. Soc. N. Z. 4 (3): 345-377. 1974. SFA 21(1).

Two species of /Raja/ are known to occur in New Zealand waters. The common "rough" skate, usually referred to /R. australis/ Macleay, 1884, or sometimes to /R. lemprieri/ Richardson, 1846, is shown to be /R. nasuta/ Banks /in/ Muller and Henle, 1841. The "smooth" skate, usually referred to /R. nasuta/, has not in fact been named, and is now described as /R. innominata/ n. sp. The rough skate, /R. nasuta/, is brownish above, usually marked with numerous small white spots and dark spots or blotches and a pair of dark ocelli; below it is predominantly white; dorsally it has prickles on most of the disc (females) or in a middorsal-trunk band (males) at all ages; ventrally the abdominal region lacks prickles except for a few in large females; the tail in medium to large specimens is relatively wide, usually with three rows of spines, and there are 56-57 predorsal-caudal vertebrae. The smooth skate, /R. innominata/, is greyish above, usually marked with several large dark spots; below it is predominantly grey; in subadults there are generally no prickles dorsally on the disc, but medium to large specimens develop prickles on the snout, in a middorsal-trunk band, and posterolaterally on the disc; medium to large specimens of both sexes have prickles ventrally on the gill and abdominal regions, and females of this size are extensively prickly below; the tail is relatively narrow, usually with one row of spines (three in large specimens), and there are 50-53 predorsal-caudal vertebrae. Either species may be conspecific with Australian skates, but there are insufficient data on the latter for proper comparison.

The deep-water skate /R. richardsoni/ Garrick, 1961, is here referred to /Bathyraja/. Two new species of /Bathyraja/ are described from New Zealand material, and a third species, known from a single juvenile, is discussed but not named. /Bathyraja asperula/ n. sp. has the upper disc surface smooth apart from a middorsal-trunk band of prickles, while /B. spinifera/ n. sp. has the upper disc surface entirely covered with prickles. Although meristic features including vertebral counts separate both these species from those described from other regions the genus is inadequately known, and /asperula/ and /spinifera/ could prove to be only nominally endemic.

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Additional specimens of the endemic */Arhynchobatis asperimus/* Waite, 1909, including the first known males, are listed and briefly discussed, but not described.

A key is given to the seven known New Zealand rajoid skates.

76-000300 Glodek, G. S. (Div. Fishes, Field Mus. Nat. Hist., Roosevelt Rd. at Lakeshore Dr., Chicago, IL 60605) */RHYNCHODORAS WOODSI/*, A NEW CATFISH FROM EASTERN ECUADOR (SIIURIFORMES: DORADICAE) WITH A REDEFINITION OF */RHYNCHODORAS/*. *Copeia* 1976 (1): 43-46. 12 ar. 1976. SFA 21(1).

A second species of */Rhynchodoras/* is described from eastern Ecuador. This new species was collected from the Rio Bobonaza of the upper Amazon drainage in eastern Ecuador, over 2735 km west of the type locality of */Rhynchodcras xingui/*, the only other known member of the genus. A comparison is made with */R. xingui/* from the Rio Xingu of eastern-central Brazil, along with a redefinition of the limits of the genus */Rhynchodoras/*.

76-000301 Greenfield, D. W. (Dep. Biol. Sci., North. Ill. Univ., DeKalb 60115) */CENTROPOMUS POEYI/* FROM BELIZE, WITH A KEY TO THE WESTERN ATLANTIC SPECIES OF */CENTROPOMUS/*. *Copeia* 1975 (3): 582-583. 5 Aug. 1975. SFA 21(1).

76-000302 Greenfield, D. W. (Dep. Biol. Sci., North. Ill. Univ., DeKalb, 60115) */EMBLEMARIOPSIS PRICEI/*, A NEW SPECIES OF CHAENOPSID BLENNY FROM BELIZE. *Copeia* 1975 (4): 713-715. 31 Dec. 1975. SFA 21(1).

/Emblemariopsis pricei/ n. sp. is described from Glovers Reef, Belize, Central America on the basis of 2 specimens. The new species is shown to be most closely related to */E. bottomei/* and */E. bahamensis/*. */Emblemariopsis pricei/* lives in holes in living branches of the coral */Acropora palmata/*.

76-000303 James, G. D.; Stephenson, A. B. (Minist. Agric. Fish., Wellington, New Zealand) */CARANX GEORGIANUS/* CUVIER, 1933 (PISCES: CARANGIDAE) IN TEMPERATE AUSTRALASIAN WATERS. *J. R. Soc. N. Z.* 4 (4): 401-410. 1974. SFA 21(1).

A review of the Australasian species */Caranx platessa/* Cuvier, */C. lutescens/* (Richardson), */C. nobilis/* Macleay, and */Usacaranx archeyi/* Griffin has shown these to be junior synonyms of */C. georgianus/* Cuvier. This species has been re-defined in terms of variation shown by specimens from temperate Australia, Lord Howe, Norfolk and Kermadec Islands, and New Zealand.

76-000304 Johnson, M. S. (Dep. Ecol. Evol., State Univ. N.Y., Stony Brook 11794) BIOCHEMICAL SYSTEMATICS OF THE ATHERINID GENUS */MENIDIA/*. *Copeia* 1975 (4): 662-691. 31 Dec. 1975. SFA 21(1).

Species of the atherinid genus */Menidia/* were compared electrophoretically for enzymes representing an apparent 24 gene loci and for nonenzymatic skeletal muscle proteins. Average allelic frequency similarities between conspecific populations range from 0.84 to 0.99, averaging 0.94. The greatest allelic frequency similarity between two populations definitely representing separate species is 0.82. At a given locus, pairs of species tend to have either essentially identical or completely different allelic frequencies.

Consistent with current taxonomic treatment, */M. menidia/* and */M. extensa/* were found to be quite distinctive from each other and from each of the other species in the genus. Populations of */M. peninsulae/*

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were consistently distinct from *M. beryllina*, with which they were formerly considered conspecific. These two species co-occur from Florida to Texas, and genetic discontinuity was verified in four areas of local sympatry. Morphological and ecological differences also were found between *M. penninsulae* and *M. beryllina*. Contrasting with all other species comparisons in the genus, no electrophoretic differences were found between *M. audens* and *M. beryllina*. Morphological analysis revealed an intermediate population in Lake Palourde, southern Louisiana, the region where the ranges of these two species approach one another. Although the structure of this population suggests hybridization, the reproductive relationships of *M. audens* and *M. beryllina* remain in doubt.

Hybridization is possible between all three of the coastal species, *M. beryllina*, *M. peninsulae* and *M. menidia*, but is common only in the zone of parapatry of *M. menidia* and *M. peninsulae* in northeastern Florida. Very little or no gene exchange between species occurs in this hybrid zone. Hybridization in *Menidia* appears to be related more to ecological similarity than to genetic similarity.

76-000305 Johnson, R. K.; Glodek, G. S. (Div. Fish., Field Mus. Nat. Hist., Roosevelt Rd. at Lakeshore Drive, Chicago, IL 60605) TWO NEW SPECIES OF *EVERMANNELLA* FROM THE PACIFIC OCEAN, WITH NOTES ON OTHER MIDWATER SPECIES ENDEMIC TO THE PACIFIC CENTRAL OR THE PACIFIC EQUATORIAL WATER MASSES. Copeia 1975 (4): 715-730. 31 Dec. 1975. SFA 21(1).

Two new species of *Evermannella* are described from the Pacific Ocean. *Evermannella ahlstromi* n. sp. is limited to the eastern Pacific where it occurs in the southern Transition Region of the North Pacific and in portions of Pacific Equatorial Water. *Evermannella megalops* n. sp. is endemic to low-productivity central water areas of the South Pacific. Each species apparently replaces the closely related and otherwise circumtropical species *E. indica* throughout much of each area. The distribution of each species is compared with the distributions of other midwater species similarly restricted in distribution and possible physical and biological correlates of these distributional patterns are discussed.

76-000306 Page, L. M. (Ill. Nat. Hist. Surv., Urbana) RELATIONS AMONG THE LARTERS OF THE SUBGENUS *CATONOTUS* OF *ETHEOSTOMA*. Copeia 1975 (4): 782-784. 31 Dec. 1975. SFA 21(1).

76-000307 Ritchie, L. D. (New Zealand Minist. Agric. Fish., Whangarei, New Zealand) SYSTEMATICS AND MERISTIC VARIATION IN THE BUTTERFISH (*ODAX PULLUS* (FORSTER)). N. Z. Minist. Agric. Fish. Fish. Tech. Rep. No. 145. 46p. 1976. SFA 21(1).

An historical review of the systematic literature of *Coriodadax pullus* Forster in Bloch and Schneider, 1801 and *Odax vittatus* Solander in Richardson, 1843 is given, and these nominal species are synonymised. *Odax pullus*, the New Zealand butterfish, is described and its form, colour, and behavioural changes with growth are discussed. Variation in the number of fin rays, scale rows and vertebrae is shown to have significant negative correlation with sea surface temperature.

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76-000308 Smith, P. W.; Page, L. M. (Ill. Nat. Hist. Surv., Urbana 61801) NOTICE OF INVALIDATION OF THE LECTOTYPE DESIGNATION OF /CATONOTUS KENNICOTTI/ PUTNAM. Copeia 1975 (4): 777-778. 31 Dec. 1975. SFA 21(1).

76-000309 Snelson, F. F.; Pflieger, W. L. (Dep. Biol. Sci., Fla. Tech. Univ., Orlando 32816) REDESCRIPTION OF THE REDFIN SHINER, /NOTROPIS UMBRATILIS/, AND ITS SUBSPECIES IN THE CENTRAL MISSISSIPPI RIVER BASIN. Copeia 1975 (2): 231-249. 23 May 1975. SFA 21(1).

The nomenclature of /Notropis umbratilis/ is clarified and an updated synonymy is presented. The species is described and distinguished from related forms. Two subspecies are recognized primarily on details of pigmentation and tuberculation. /N. u. umbratilis/ is distributed in the Salt River drainage, the Missouri River drainage and the central Arkansas River drainage. /N. u. cyanocephalus/ has a complementary distribution in the central Mississippi River basin and is widespread outside the study area. Although close to the specific level of divergence, these two forms have exchanged genes in the lower Salt River drainage and the Arkansas River system. The pattern of intergradation is different in the two areas. Variation and zoogeography of the two subspecies in the central Mississippi River basin are discussed.

76-000310 Springer, S.; Gilbert, P. W. (Mote Mar. Lab., 9501 Blind Pass Rd., Sarasota, FL 33581) THE BASKING SHARK, /CETORHINUS MAXIMUS/, FROM FLORIDA AND CALIFORNIA, WITH COMMENTS ON ITS BIOLOGY AND SYSTEMATICS. Copeia 1976 (1): 47-54. 12 Mar. 1976. SFA 21(1).

The known range of the basking shark is extended to the Gulf of Mexico by an adult female taken alive at Sarasota, Florida. Comparisons of some characters of the specimens are made with those of an adult male from in Drake's Bay, California and those of an immature specimen from the east coast of Florida. Although the Sarasota specimen differs in denticle form and in some other respects from basking sharks of the eastern North Atlantic and elsewhere, it is provisionally identified as /Cetorhinus maximus/ (gunnerus), here regarded as the only extant species of its genus and family. Reasons for the presence of the Sarasota specimen in warm shallow water 190 km from the continental shelf edge are postulated.

76-000311 Sturgess, J. A. (Div. Wildl. Fish., Univ. Calif., Davis 95616) TAXONOMIC STATUS OF /PERCINA/ IN CALIFORNIA. Calif. Fish Game 62 (1): 79-81. Jan. 1976. SFA 21(1).

76-000312 Thomerson, J. E.; Taphorn, D. C.; Foster, N. R.; Turner, B. J. (Dep. Biol., South. Ill. Univ., Edwardsville 62025) /RACHOVIA SPLENDENS/ DAHL, A SYNONYM OF THE ANNUAL KILLFISH /RACHOVIA BREVIS/ (REGAN). Copeia 1976 (1): 204-207. 12 Mar. 1976. SFA 21(1).

76-000313 Thorson, T. B.; Watson, D. E. (Sch. Life Sci., Univ. Nebr., Lincoln 68588) REASSIGNMENT OF THE AFRICAN FRESHWATER STINGRAY, /POTAMOTRYGON GABOUAENSIS/, TO THE GENUS /DASYATIS/, ON PHYSIOLOGIC AND MORPHOLOGIC GROUNDS. Copeia 1975 (4): 701-712. 31 Dec. 1975. SFA 21(1).

Three specimens of the freshwater stingray, /Potamotrygon garouaensis/ Stauch and Blanc, from the Benue River at Makurdi, Nigeria, did not have the prepelvic process diagnostic of the family Potamotrygonidae, nor did they have the extremely low urea concentration in their body fluids characteristic of that family in

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South America. All relevant morphologic parameters examined agreed with the diagnoses given for */Dasyatis/* by Garman and by Bigelow and Schroeder. We recommend reassignment of the Garoua stingray from the genus */Potamotrygon/* to */Dasyatis/*. Both African and South American fossil rays ascribed to the genus */Potamotrygon/* are also likely to be members of the genus */Dasyatis/* or another genus of the family Dasyatidae.

The extensive speciation that has occurred among South America potamotrygonid freshwater rays, as well as their radical departure from the osmoregulatory features of the rest of the elasmobranchs, suggests a relatively long residence in fresh water. On the other hand, the Garoua stingray and other dasyatid rays that appear to be permanent residents of fresh water may have invaded freshwater systems relatively recently. The former deal with their osmotic problems like freshwater osteichthians; the latter like other euryhaline elasmobranchs.

76-000314 Turner, B. J.; Liu, R. K. (Rockerfeller Univ., New York, NY 10021) THE SPECIFIC IDENTITY OF THE INTRODUCED PUFFISH POPULATION AT ZZYXZ SPRING, CALIFORNIA. Copeia 1976 (1): 211-212. 12 Mar. 1976. SFA 21(1).

76-000315 Villa, J.; Miller, R. R. (Cornell Univ., Langmuir Lab., Ithaca, NY 14850) IDENTITY OF THE CENTRAL AMERICAN CICHLID FISH */CICHLASOMA BOUCHELLEI/* FLOWLER. Copeia 1975 (4): 778-780. 31 Dec. 1975. SFA 21(1).

76-000316 White, R. G. ENDEMIC WHITEFISHES OF BEAR LAKE, UTAH-IDAHO: A PROBLEM IN SYSTEMATICS. Ph.D. dissertation, Utah State Univ. 225p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(1), 1975. SFA 21(1).

The systematic status of whitefishes endemic to Bear Lake, Utah-Idaho, has remained tenuous since their original description. Clarification of this problem was the major objective of the present study. The general approach was an integrated one, including examination of morphological, biochemical and ecological parameters; artificial hybrids were produced and compared with questionable groups from the natural population.

Morphological analysis revealed five forms of Bear Lake whitefishes. */Prosopium gemmiferum/* (Bonneville cisco) and */P. abyssicola/* (Bear Lake whitefish) were well differentiated from other forms and were treated as originally described. The */P. spilonotus/* (Bonneville whitefish) group, however, was found to be made up of two morphologically distinct populations, referred to as */P. spilonotus/* (small form) and */P. spilonotus/* (large form). The fifth group referred to as */P. gemmiferum/-like* (represented by only five specimens) was intermediate between */P. gemmiferum/* and either */P. spilonotus/* (small form) or */P. abyssicola/* and was hypothesized to be of hybrid origin. Multiple discriminant function analysis of the four major groups and */P. williamsoni/* (mountain whitefish) (Logan River) confirmed morphological differentiation between forms.

Hybridization studies among Bear Lake */Prosopium/* and */P. williamsoni/* involved 50 homo- and heterospecific crosses (17 combinations). Of 12 experimental hybrid combinations attempted, all those involving simultaneously ripe specimens of two groups (five crosses) showed maximum fertilization success equalling that of pure crosses.

Morphological and ecological analyses, combined with results of experimental hybridization, provided abundant evidence supporting separate recognition of the two forms of */P. spilonotus/*. Karyotypes of

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/P. gemmiferum/, /P. abyssiicola/ and /P. spilonotus/ (small form) have been determined (Booke, 1974) and are unique for each species. If the karyotype of /P. spilonotus/ (large form) is found to also be unique, there should be no question that the two forms of /P. spilonotus/ represent distinct species. Final clarification of the taxonomic status of these forms will not come until karyotype data is available; however, based upon present evidence, tentative recognition of a new species is recommended. (From Auth Abstr.)

76-000317 Wiley, E. O. III; Hall, D. D. (Dep. Ichthyol. Am. Mus. Nat. Hist., Central Park West at 79th St., New York, NY 10024) /FUNDULUS BLAIRAE/, A NEW SPECIES OF THE /FUNDULUS NOTTII/ COMPLEX (TELEOSTEI, CYPRINODONTIDAE). Am. Mus. Novit. No. 2577. 13p. May 1975. SFA 21(1).

/Fundulus blairae/ is described from material from eastern Texas, southeastern Oklahoma, and western Louisiana. A phylogenetic analysis indicates that /F. blairae/ is a member of the /Fundulus nottii/ species group and is most closely related to /F. dispar/. The analysis also indicates that /F. cingulatus/ is most closely related to the /F. nottii/ species group. /Fundulus nottii/ and /F. lineolatus/, the other members of the species group, are sympatric with each other, whereas /F. dispar/ and /F. blairae/ are allopatric, both with each other and with the other two species. A phylogeny of the /F. nottii/ complex and three other species of /Fundulus/ is presented.

PARASITES AND DISEASES-GENERAL

76-000318 Hare, G. M. ATLANTIC SALMON (/SALMO SALAR/) PARASITES AS BIOLOGICAL TAGS IN THE MIRAMICHI RIVER SYSTEM, NEW BRUNSWICK. Ph.D. dissertation, Univ. New Brunswick 1974. From Diss. Abstr. Int. B Sci. Eng. 35(10), 1975. [Order microfiche copy from the National Library of Canada at Ottawa.] SFA 21(1).

Fourteen parasite species (1 protozoan, 11 helminth, 1 crustacean, 1 mollusc) were collected from 1,733 juvenile Atlantic salmon (/Salmo salar/) in the Miramichi River system, New Brunswick, during the period October 1969 to November 1971. Of sixty adult salmon examined, none were infected with parasites of freshwater origin. The effect of host age, size, sex and season on the abundance of parasites infecting juvenile salmon in a small stream, Trout Brook, was determined.

The effect of salinity on parasites was determined by comparing the abundance of parasites infecting smolts of Northwest Miramichi origin collected from the river and from the Miramichi estuary. Each parasite recovered from smolts in the river was also found in estuarine samples. The usefulness of parasites as biological tags in the stream management of Atlantic salmon is discussed. (From Auth. Abstr.)

76-000319 Heartwell, C. M. III (W. Va. Dep. Nat. Resour., P.O. Box 67, Elkins 26241) IMMUNE RESPONSE AND ANTIBODY CHARACTERIZATION OF THE CHANNEL CATFISH (/ICTALURUS PUNCTATUS/) TO A NATURALLY PATHOGENIC BACTERIUM AND VIRUS. U.S. Fish Wildl. Serv. Tech. Pap. 85. 34p. 1975. SFA 21(1).

Inoculation of channel catfish (/Ictalurus punctatus/) with /Chondrococcus columnaris/ cells and channel catfish virus resulted in a rapid primary response to both antigens. The secondary response to the bacterium was rapid but weaker than that often seen in warmblooded animals, whereas the secondary response to virus was weak, variable, and of relatively short duration.

Analysis of total serum proteins and selected isozyme systems by

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acrylamide gel electrophoresis revealed differences between normal and experimental fish serums in the number of serum protein components and in the number of bands of acid phosphatase, esterase, and lactic acid dehydrogenase isozymes.

Specific antibody activity of the immune serums occurred in the macroglobulin serum fraction. The macroglobulin fraction was further separated into two antibody populations by anion exchange chromatography. Antibody activity was diminished by 30 minutes exposure to 50 C, and reduction with 2-mercaptoethanol and alkylation markedly lowered antibody activity. The partly purified antibodies had a molecular weight of 800,000 to 900,000 daltons.

Immunoelectrophoresis of antibacterial serums produced two specific immunoglobulin arcs of beta to gamma mobility, and antiviral serums produced one immunoglobulin arc of alpha mobility.

Partial antibody characterization indicates that specific channel catfish immunoglobulins are macroglobulins with characteristics like those of most fish immunoglobulins and similar to those of human immunoglobulin-M.

76-000320 Herman, R. L. SOME LESIONS IN THE HEART OF TROUT. In W. E. Ribelin and G. Migaki, eds. The Pathology of Fishes, Univ. Wis. Press, Madison. 331-342. 1975. SFA 21(1).

76-000321 Meyer, P. P.; Hoffman, G. L. (U.S. FWS, Fish Farming Exp. Stn., Stuttgart, AR 72160) PARASITES AND DISEASES OF WARMWATER FISHES. U.S. Fish Wildl. Serv. Resour. Publ. 127. 20p. Apr. 1976. SFA 21(1).

Diseases and parasites affecting fish raised in fish farming ponds are major subjects of investigation at the Fish Farming Experimental Station of the U.S. Fish and Wildlife Service. Studies are conducted on identification, control, and distribution and, for parasites, the life history. General information is presented here on a few of the more common disease and parasite problems. It is hoped that this summary will help the reader recognize some of the more common diseases and parasites and understand some of the problems of the fish farmer. (From Auth. Intro.)

BACTERIAL DISEASES

76-000322 Bootsma, R.; Clerx, J. P. M. (Dep. Spec. Anim. Pathol., Fac. Vet. Med., Utrecht, The Netherlands) COLUMNARIS DISEASE OF CULTURED CARP /CYPRINUS CARPIO/ L. CHARACTERIZATION OF THE CAUSATIVE AGENT. Aquaculture 7: 371-384. 1976. SFA 21(1).

A carp disease, initially diagnosed as carp erythrodermatitis (CE), has occurred enzootically since 1972 at a hatchery near Lelystad, The Netherlands. Gliding bacteria belonging to the Cytophaga family were repeatedly isolated from external lesions in affected carp. These isolates were examined, and compared with reference strains of /Flexibacter columnaris/, formerly known as /Chondrococcus columnaris/ or /Cytophaga columnaris/. Comparative tests included cell morphology and motility, growth under various environmental conditions, physiological characteristics, agglutination, determination of DNA base composition and antibiograms. All carp isolates that produced strongly rhizoid colonies on basal agar medium were identified as /Flexibacter columnaris/.

Freshly isolated strains of /F. columnaris/ were pathogenic to carp, producing ulcers surrounded by a red zone, and the bacteria were re-isolated from infected fish. For these reasons the carp disease at

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Lelystad hatchery is diagnosed as columnaris disease (Davis, 1922); an earlier diagnosis of carp erythrodermatitis (Bootsma, 1973) should be reconsidered.

Further investigations, not reported in this paper, have confirmed that carp erythrodermatitis and columnaris disease are separate diseases with different aetiologies.

76-000323 Glenn, J. S. THE IMMUNE RESPONSE OF THE CHANNEL CATFISH (/ICTALURUS PUNCTATUS/, RAFINESQUE). Ph.D. dissertation, Univ. Ga. 118p. 1974. From. Diss. Abstr. Int. B Sci. Eng. 35(10), 1975. SPA 21(1).

Antibody activity in sodium sulfate precipitated channel catfish serum was detected only in the protein fractions excluded from a Bio-Gel P-200 column. When tissue and organ sections were examined with fluorescein labeled rabbit anti-channel catfish immunoglobulin serum the greatest concentrations of immunoglobulin containing cells were found in the anterior and posterior kidneys. The spleen contained a smaller proportion of such cells and only isolated immunoglobulin containing cells were found in the liver, intestine and skin. None of the cells in the epithelial layer of the intestine or in the epidermal layer of the skin exhibited any fluorescence when examined with the above conjugate. No immunoglobulins or antibody activity could be detected in intestinal or external surface mucus.

Antibodies, detected by agglutination tests, were produced soon after immunization of channel catfish, however antibodies could not be detected by precipitation tests, even after extended periods of immunization. As the water temperature was lowered, the latent period of the immune response increased in length and the magnitude of the antibody response decreased. Although oral immunization did not result in a detectable serum antibody response, secondary stimulation by parenteral injection revealed that a priming of the immune system had occurred.

Serologic cross reactions between the Red Mouth Bacterium and /Aeromonas hydrophila/ and /A. shigelloides/ indicate that the Red Mouth Bacterium may be closely related to members of the genus /Aeromonas/. Although the pathogenicity of the Red Mouth Bacterium to channel catfish increases with the magnitude of the challenge and also with decreasing water temperatures, channel catfish are much more resistant to fatal infection than are rainbow trout.

76-000324 Novotny, A. J.; Harrell, L. W.; Nyegaard, C. W. (NMFS, Manchester, WA) VIBRIOSIS: A COMMON DISEASE OF PACIFIC SALMON CULTURED IN MARINE WATERS OF WASHINGTON. Wash. State Univ. Coop. Ext. Serv. Ext. Bull. 663. 8p. Sept. 1975. SPA 21(1).

76-000325 Rohovec, J. S.; Garrison, R. L.; Fryer, J. L. (Dep. Microbiol., Oreg. State Univ., Corvallis 97331) IMMUNIZATION OF FISH FOR THE CONTROL OF VIBRIOSIS. In Proc. Third U.S.-Japan Meeting on Aquaculture, Tokyo, Japan, Oct. 15-16, 1974. Spec. Publ. Fish. Agency, Japanese Govt. Japan Sea Reg. Fish. Res. Lab., Niigata. 105-112. Oct. 1975. SPA 21(1).

Efficacious vaccines were developed for the control of /Vibrio anguillarum/, the etiological agent of vibriosis in salmonid fish. These bacterians can be administered either orally or parenterally. It was determined that both formalin-killed lyophilized whole cells and wet-packed whole cells of the organism are effective oral immunogens. Intraperitoneal injection of 0.1 ml containing 2×10^8 formalin-killed bacterial cells suspended in saline and mixed with Freund complete adjuvant is capable of providing protection to fish exposed to natural challenge with /V. anguillarum/.

SPORT FISHERY ABSTRACTS

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Several parameters under which the oral vaccine can be effectively used were examined. These investigations revealed that protection is provided to fish vaccinated for 15 days with a ration containing 0.5 mg of the wet whole cell vaccine per gram. Increasing the number of days the vaccine was fed to as many as 45 days did not increase the degree of resistance in immunized fish. Decreased mortality was also not observed in groups of fish fed a diet containing higher concentrations of vaccine. Other studies demonstrated that oral immunization of fish can be successfully accomplished at water temperatures ranging from 4 to 21 C.

FUNGAL DISEASES

76-000326 Mayer, F. L. (U.S. FWS, Fish-Pesticide Lab, Columbia, MO 65201) 2,4-D REDUCES /SAPROLEGNIA/ ON FATHEAD MINNOW EGGS. Prog. Fish-Cult. 38 (1): 19. Jan. 1976. SFA 21(1).

Adult fathead minnows (/Fimphales promelas/) were continuously exposed to 0.12 to 2.0 mg/l of 2,4-D DMA through spawning. /Saprolegnia/, a common fungal infection of fish eggs, was reduced on the resulting eggs in relation to exposure concentration.

PROTOZOAN DISEASES

76-000327 Burreson, E. M. BIOLOGICAL STUDIES ON THE HEMOFLAGELLATES OF OREGON MARINE FISHES AND THEIR POTENTIAL LEECH VECTORS. Ph.D. dissertation, Oreg. State Univ. 143p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(4), 1975. SFA 21(1).

Of 2122 marine fishes belonging to 36 species collected in the vicinity of Newport, Oregon, 541 belonging to 8 species were infected with hemoflagellates. Four species of trypanosomes and three species of cryptobias were found in offshore fishes, but no hemoflagellates were observed in fishes from Yaquina Bay. (From Auth. Abstr.)

VIRAL DISEASES

76-000328 Grischowsky, R. S.; Amend, D. F. (Alaska Dep. Fish Game, Anchorage 99502) INFECTIOUS HEMATOPOIETIC NECROSIS VIRUS: PREVALENCE IN CERTAIN ALASKAN SOCKEYE SALMON, /ONCORHYNCHUS NERKA/. J. Fish. Res. Board Can. 33 (1): 186-188. Jan. 1976. In English with French summ. SFA 21(1).

Infectious hematopoietic necrosis (IHN) virus is reported for the first time in Alaskan sockeye salmon (/Oncorhynchus nerka/). The virus was isolated from moribund juveniles at Kitoi Bay and from adults of 16 spawning stocks throughout the Bristol Bay, Kodiak Island, Cook Inlet, and the Gulf of Alaska areas.



OTHER DISEASES AND PARASITES

76-000329 Armstrong, H. W. A STUDY OF THE HELMINTH PARASITES OF THE FAMILY MACROURIDAE FROM THE GULF OF MEXICO AND CARIBBEAN SEA: THEIR SYSTEMATICS, ECOLOGY AND ZOOGEOGRAPHICAL IMPLICATIONS. Ph.D. dissertation, Texas A&M Univ. 346p. 1974. From Diss. Abstr. Int. B Sci. Eng. 36(1), 1975. SFA 21(1).

Two hundred and seventy-five macrourids, representing 21 species, were examined for their helminth parasites. Macrourids were collected in the Eastern Gulf of Mexico and Southern Caribbean Sea between the depths of 364 and 1,454 meters. Four monogenetic trematodes, 32 digenetic trematodes, 16 cestodes, 30 nematodes and two acanthocephalans were found. The digenetic trematodes include one new subfamily, four new genera and 15 new species. Two new species of monogenetic trematodes and 12 new species of nematodes are also described. Another four species of digenetic trematodes, 10 of nematodes and 1 acanthocephalan could not be identified with previously described species. All of the cestodes were larval. The incidence of infections were Monogenea 5 percent, Digenea 60 percent, Cestoda 80 percent, Nematoda 75 percent and Acanthocephala 2.5 percent. The helminth fauna of the macrourids examined is distinct from that of nearby shallow-water fishes and more like that of distant cold waters. The bathygadine macrourids had fewer helminths than the macrourine macrourids which may be correlated to feeding habits. The digenetic trematode and nematode fauna appears to be as rich as that of shallow-water fishes.

76-000330 Ashmead, R. R.; Crites, J. L. (Dep. Zool., Ohio State Univ., Columbus 43210) A DESCRIPTION OF THE MALE AND REDESCRIPTION OF THE FEMALE OF /PHILOMETRA CYLINDRACEA/ WARD AND MAGATH, 1916 (NEMATODA: PHILOMETRIDAE). Proc. Helminthol. Soc. Wash. 42 (2): 143-145. July 1975. SFA 21(1).

The male and mature female are described for the first time and the gravid female description is amended to include three lips and some additional measurements.

76-000331 Bouck, G. B.; Chapman, G. A.; Schneider, P. W., Jr.; Stevens, D. G. (U.S. EPA, 1350 S. E. Goodnight Ave., Corvallis, OR 97330) OBSERVATIONS ON GAS BUBBLE DISEASE AMONG WILD ADULT COLUMBIA RIVER FISHES. Trans. Am. Fish. Soc. 105 (1): 114-115. Jan. 1976. SFA 21(1).

A high incidence of gas bubble disease was found among salmonids and shad sampled from the air-supersaturated Columbia River. Post-capture eye damage to sockeye salmon also may be related to supersaturation of the river.

76-000332 Fickeisen, D. H.; Schneider, M. J. (eds.) GAS BUBBLE DISEASE: PROCEEDINGS OF A WORKSHOP HELD AT RICHLAND, WASHINGTON, OCTOBER 8-9, 1974. Tech. Inf. Cent., Off. Public Aff., Energy Res. Develop. Adm., Washington, D.C. 132p. 1976. Available as CONF-740133/RAS from National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161, at \$6.00 (foreign, \$8.50). SFA 21(1).

Aquatic organisms exposed to water supersaturated with dissolved gases are subject to gas bubble disease. In severe cases mortality rates are high and secondary effects have been identified in less severe cases. Two mechanisms resulting from man's activities result in dissolved gas supersaturation: entrainment of air into falling water

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such as occurs at dam spillways and heating of water to decrease gas solubilities as has been identified in power plant effluents. The problem is particularly severe in the Columbia-Snake River system. In recent years it has been recognized and reported in other river systems and both freshwater and marine environments receiving thermal discharges.

This book is the first compendium of research results from the many laboratories dealing with gas bubble disease. The workshop was held to provide a forum for the exchange of information and to identify the state-of-the-art of knowledge of the effects of dissolved gas supersaturation. The proceedings include formal papers as well as summaries of five informal round-table discussions. The discussions had as their goal the definition of research needs related to gas bubble disease in each of their topic areas.

76-000333 Hogan, T. M.; Williams, B. S. (WAPORA, Inc., 4901 Foley Rd., Cincinnati, OH 45238) OCCURRENCE OF THE GILL PARASITE /ERGASILUS LABRACIS/ CN STRIPED BASS, WHITE PERCH AND TOMCOD IN THE HUDSON RIVER. N. Y. Fish Game J. 23 (1): 97. Jan. 1976. SFA 21(1).

76-000334 Jones, D.; Lewis, D. H. (Dep. Vet. Microbiol., Texas A&M Univ., College Station 77840) GAS BUBBLE DISEASE IN FRY OF CHANNEL CATFISH (/ICTALURUS PUNCTATUS/). Prog. Fish-Cult. 38 (1): 41. Jan. 1976. SFA 21(1).

Gas bubble disease was observed in the fry of channel catfish (/Ictalurus punctatus/) that were being maintained in a 400-liter culture unit in intensively aerated water at 22-25 C. Hyperaeration was presumed to be responsible for the 85 percent mortality in one lot of fry 6-8 weeks old within a week after being placed in the unit; the fry had large air emboli lodged in the peritoneal cavity.

76-000335 Keppner, E. J. (Dep. Biol., Cent. Mo. State Univ., Warrensburg 64093) LIFE CYCLE OF /SPINITECTUS MICRACANTHUS/ CHRISTIAN, 1972 (NEMATODA: RHAEDOCHONIDAE) FROM THE BLUEGILL, /LEPOMIS MACROCHIRUS/ RAFINESQUE, IN MISSOURI WITH A NOTE ON /SPINITECTUS GRACILIS/ WARD AND MAGATH, 1917. Am. Midl. Nat. 93 (2): 411-423. Apr. 1975. SFA 21(1).

The development of /Spinitectus micracanthus/ is described in the intermediate host, /Hexagenia/ sp. (Insecta: Ephemeroptera), and in the definitive host, /Lepomis macrochirus/. Larval development occurs primarily in the abdominal muscles of /Hexagenia/ sp., and encysted, third-stage larvae were present in the muscles 20 days postinfection. Males with sperm in the reproductive tract were recovered from the intestine of the definitive host 26 days postinfection, and females containing eggs were recovered from the intestine 36 days postinfection of the definitive host. Infective larvae of /S. micracanthus/ were compared with larvae of /S. gracilis/ obtained from naturally infected /Hexagenia/ sp.

76-000336 Lester, R. J. G.; Daniels, B. A. (Dep. Microbiol. Parasitol., Fac. Med., Univ. Toronto, Toronto, ON M5S 1A1, Canada) THE EOSINOPHILIC CELL OF THE WHITE SUCKER, /CATOSTOMUS COMMERSONI/. J. Fish. Res. Board Can. 33 (1): 139-144. Jan. 1976. In English with French summ. SFA 21(1).

The inflammatory reaction of /Catostomus commersoni/ to the parasites /Actinobdella inequianulata/ and /Lerneae cyprinacea/, and to an experimental incision, produced tissue that contained large numbers of eosinophilic granulocytes. The cells had spherical nuclei and orange granular cytoplasm after H & E staining. In imprints of the

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same tissue treated with Romanowsky stains the cells had a flocculent weakly basophilic cytoplasm and sometimes contained purple granules. They were peroxidase negative. "Finely reticular cells" found in the blood had an identical appearance to the cells observed in the imprints, and were thought to be the same type of cell. They may be equivalent to mammalian eosinophils.

76-000337 Mudry, D. B.; McCart, P. J. (Dep. Biol., Univ. Calgary, Calgary, AB T2E 6M9, Canada) METAZOAN PARASITES OF ARCTIC CHAR (*SALVELINUS ALPINUS*) FROM THE NORTH SLOPE OF CANADA AND ALASKA. J. Fish. Res. Board Can. 33 (2): 271-275. Feb. 1976. In English with French summ. SFA 21(1).

Fourteen species of metazoan parasites were recovered from a total of 128 *Salvelinus alpinus* from the north slope of Canada and Alaska collected between March 31, 1971 and November 5, 1972. The parasites consisted of one monogenean, four digeneans, four cestodes, two nematodes, one acanthocephalan, and two copepods. Of the parasites recovered, one was described as a new species (*Bulbodacnitis alpinus*/ Mudry and McCart, 1974) and three others are new North American host records (*Tetraonchus alaskensis*/, *Cystidicola stigmatura*/, and *Cyathocephalus truncatus*/). All of the localities sampled during this study are range extensions of the parasites found.

76-000338 Muzzall, P. M.; Rabalais, F. C. (Dep. Biol. Sci., Bowling Green State Univ., Bowling Green, OH 43403) AN ABERRANT ASSOCIATION BETWEEN *PROTEOCEPHALUS* SP. AND *ACANTHOCEPHALUS JACKSONI*. Am. Midl. Nat. 94 (1): 240-241. July 1976. SFA 21(1).

Four male *Acanthocephalus jacksoni*/, a common parasite of fish, were found attached to a cestode (*Proteocephalus* sp.).

76-000339 Paperna, I. (H. Steinitz Mar. Biol. Lab., Elat, Israel) SKIN EPITHELIONA IN THE ELECTRIC CATFISH *MALAPTERURUS ELECTRICUS*/ FROM LAKE ALBERT, EAST AFRICA. Copeia 1975 (2): 374-377. 32 May 1975. SFA 21(1).

76-000340 Rokicki, J. (Res. Cent. Parasitol., Polish Acad. Sci., Warszawa, Poland) HELMINTH FAUNA OF FISHES OF THE GDANSK BAY (BALTIC SEA). Acta Parasitol. Pol. 23: 37-84. Apr. 1975. SFA 21(1).

Examination of 923 fishes of 40 species revealed 42 helminth species. Trematodes (20 species) and cestodes (12) were the predominant parasite groups both as regards the number of species and the incidence and intensity of infection. Nematodes (4 species) and acanthocephalans (6) were much rarer and less numerous parasites. Cestodes *Schistocephalus fungitii*/ (plerocercoid) and *Proteocephalus longicollis*/, the nematode *Camallanus truncatus*/ and the acanthocephalan *Pomphorhynchus kostylewi*/ are first records in Poland, the latter being the first record in the Baltic Sea. Of the 42 helminth species recorded, 30 were found to occur in new host species. A total of 62 new parasite-host system which are new for Poland, including 29 systems new to science, have been demonstrated. Descriptions of *Allocreadium isoporum*/, *Palaeorchis unicus*/, *Asymphyllodora kubanicum*/ and *Pomphorhynchus kostylewi*/ were supplemented. *Asymphyllodora imitans*/ from "A" of Witenberg and Eckmann 1934 is regarded a synonym of *A. kubanicum*/ (Issaïtschikoff, 1923); *Palaeorchis skrjabini*/ Koval, 1950 of *Palaeorchis unicus*/ Szidat, 1943; *Caryophyllaeus* sp. of Janiszewski 1938 is recognized as *C. laticeps*/ (Pall., 1781). The structure of the helminth fauna of fishes under study, based on the author's findings and on data from literature, is discussed in detail.

SPORT FISHERY ABSTRACTS

76-000341 Samuel, N. ACANTHOCEPHALA OF NEBRASKA FISHES. Ph.D. dissertation, Univ. Nebr. 94p. 1974. From Diss. Abstr. Int. 2 Sci. Eng. 35(8), 1975. SFA 21(1).

Two thousand sixty fishes from Nebraska, comprising 56 species representing 17 families, were examined for Acanthocephala from 1971 through 1973. Fish were collected from the 51 sites representing major ecological regions across the state. Two hundred fifty-six fish (12.4 percent) were infected. The percentage of infected fishes varied from one family to another. (From Auth. Abstr.)

76-000342 Whitaker, J. O., Jr.; Schlueter, R. A. (Dep. Life Sci., Ind. State Univ., Terre Haute 42809) OCCURRENCE OF THE CRUSTACEAN PARASITE, /LERNAEA CYPRINACEA/, ON FISHES FROM THE WHITE RIVER AT PETERSBURG, INDIANA. Am. Midl. Nat. 93 (2): 446-450. Apr. 1975. SFA 21(1).

The crustacean parasite /Lernaea cyprinacea/ was found on 17 of 50 species of fish examined from the White River at Petersburg, Indiana, as well as on a hybrid form and on fishes of the genus /Carpiodes/, not identified to species. Forms parasitized, listed by decreasing incidence, were /Lepomis gulosus/, /L. humilis/, /Ictichus bubalus/, /Aplodinotus gunnensis/, /L. macrochirus/, /Etheostoma asprigene/, /Phenacobius mirabilis/, /L. cyanellus/, /L. megalctis/, /Fundulus notatus/, /Pimephales vigilax/, /L. hybrids/, /Micropterus punctulatus/, /Mortopis blennius/, /Carpiodes/ sp., /N. whipplei/, /N. atherinoides/, /N. spilopterus/ and /hybognathus nuchalis/. /Lernaea/ was most common fish during the summer and early autumn and was more abundant on larger fish. The incidence of parasitism tended to be lower in the more abundant host species. Fins and fin bases were the regions most frequently used for /Lernaea/ attachment.

POLLUTION

76-000343 Brynildson, O. M.; Mason, J. W. (Wis. Dep. Nat. Resour., Madison 53701) INFLUENCE OF ORGANIC POLLUTION ON THE DENSITY AND PRODUCTION OF TROUT IN A WISCONSIN STREAM. Wis. Dep. Nat. Resour. Tech. Bull. No. 81. 16p. 1975. SFA 21(1).

It took three years following the construction of new sewage treatment facilities for a wild brown trout (/Salmo trutta/ Linnaeus) population to recover its former numbers after being nearly destroyed by organic pollution. Four years after pollution abatement wild brown trout exceeded their prepollution stock levels, and both production and numerical density of trout continued to rise until the completion of the study in 1973. The highest annual production and highest biomass of wild brown trout in the study area was 39.6 g/m² and 458 kg/ha (409 lbs/acre), respectively, in a 713-meter section in the center of the former zone of pollution during 1972-73. Before the fish kill in July, 1963, biomass of wild brown trout in April, 1963 was 219 kg/ha (195 lbs/acre) in this section. The highest annual production of wild brown and domesticated brook, brown and rainbow trout combined was 47.2 g/m² during 1961-62 in a 1,513-meter section of the former zone of pollution.

There were significant inverse relationships between numerical density of trout and the average length of wild brown trout in September, 1972. Numerical density of age 0 wild brown trout alone accounted for 77 percent of the variability in the average length of this age group in September, 1972. When the number of older wild brown trout was added, an additional 15 percent of the variability in

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average length of age 0 wild brown trout was accounted for.

76-000344 Colwell, R. R.; Nelson, J. D., Jr. (Univ. Md., College Park 20742) METABOLISM OF MERCURY COMPOUNDS IN MICROORGANISMS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-600/3-75-007. x + 83p. Oct. 1975. SFA 21(1).

This report describes the physiology and ecology of mercury-resistant, mercury-metabolizing bacteria from Chesapeake Bay. Evidence is presented which establishes a role for bacteria in the cycling of mercury in the estuarine environment.

Mercury-resistant aerobic, heterotrophic bacteria were isolated from water and sediment at six stations, representing various levels of environmental quality, in upper Chesapeake Bay. These organisms were found to be resistant to an array of inorganic and organic mercury compounds and heavy metal ions. It was also observed that in individual cultures demonstrating resistance to $HgCl_2$ and phenylmercuric acetate, the resistance was adaptive and was also related to metabolic capability for degrading the compounds to elemental mercury (Hg^0). However, cultures in the process of adaptation evidenced delayed growth and cell division, which were dependent upon mercury concentration. The cultures also developed a variety of morphological irregularities associated with cell wall and cytoplasmic membrane synthesis and function.

From the results of a survey of Hg^{++} production among a group of randomly selected, $HgCl_2$ -resistant bacteria and mixed natural microbial populations, it was established that the enumeration of mercury-resistant bacteria by plate counting is a valid index of potential Hg^{++} metabolism *in situ*.

The population of mercury-resistant bacteria, primarily *Pseudomonas* spp., varied quantitatively in time and from station to station. The distribution of mercury-resistant bacteria was significantly different in water and sediment, from station to station, and seasonally. Yet, the proportion of Hg^{++} resistant bacteria among the total, viable, heterotrophic bacterial population reached a reproducible maximum in spring and was positively correlated with water turbidity, dissolved oxygen concentration, and mercury concentration in the sediment.

These findings and the observation of the evolution of Hg^{++} from freshly collected water and sediment suggest that bacteria may contribute substantially to the mobilization and transformation of mercury from existing deposits in Chesapeake Bay, specifically, and in the aquatic environment, in general.

76-000345 Haile, C. L.; Veith, G. D.; Lee, G. F.; Boyle, W. C. (Water Chem. Prog., Univ. Wis., Madison) CHLORINATED HYDROCARBONS IN THE LAKE ONTARIO ECOSYSTEM (IFYGL). U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-022. v + 28p. June 1975. SFA 21(1).

Lake Ontario fish, water, sediment, net plankton, *Cladophora*, and benthos were examined for DDT group pesticides, dieldrin, and PCBs. Endrin, BHC group pesticides, and heptachlor were also identified in some fish samples. Average concentrations ranged from 28 ng/l (t-DDT, e.e., sum of DDT, DDE, and DDD), 4.8 ng/l (dieldrin), and 55 ng/l (PCBs as Aroclor 1254 equivalent) for water to 1.40 ug/g (t-DDT), 0.07 ug/g (dieldrin), and 5.15 ug/g (PCBs) for whole fish. DDE levels were generally similar to t-DDT levels, except for sediments where DDD and DDT contributed significantly to t-DDT values. PCB/t-DDT ratios averaged 2.6 for all samples except for sediment (7.0) and benthos (5.3).

SPORT FISHERY ABSTRACTS

76-000346 Hill, J. IV; Kolliq, H. P.; Paris, D. F.; Wolfe, N. L.; Zepp, R. G. (U.S. EPA, Environ. Res. Lab., Athens, GA 30601) DYNAMIC BEHAVIOR OF VINYL CHLORIDE IN AQUATIC ECOSYSTEMS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-600/3-76-011. ix + 63p. Jan. 1976. SFA 21(1).

To evaluate the behavior of vinyl chloride in aquatic ecosystems, best estimate and worst case models of lake and stream ecosystems were analyzed through the use of mathematical simulation. The characteristics of the chemical, biological, and physical transformations of vinyl chloride indicated in the models were determined by laboratory experimentation and extrapolation of reaction data for similar compounds. These transformations included oxidation, substitution, elimination, hydrolysis, and free radical reactions; complexation; direct and indirect photochemical reactions; microbial degradation and toxicity; bacterial, algal, and fungal sorption; and volatilization. Loss of vinyl chloride from the aquatic environment by volatilization appeared to be the most significant process in its distribution.

76-000347 Hudson, P. L. (U.S. FWS, Southeast Reservoir Invest., P.O. Box 429, Clemson, SC 29631) THERMAL EFFLUENT AND THE DISTRIBUTION AND ABUNDANCE OF BENTHOS IN KEOWEE RESERVOIR, SOUTH CAROLINA. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

Keowee Reservoir, a 7400 ha impoundment, with a maximum and mean depth of 46 and 16 m, respectively, is the source of cooling water for Oconee Nuclear Station (2658 MW). Cooling water is withdrawn from a depth of 20-30 m and returned to the reservoir at a depth of 11-14 m. A thermal plume (1-5 C above natural) extends from the surface to a depth of 16-28 m and covers approximately 20 percent of the reservoir from September to April. Since the nuclear plant has been in operation, the depth at which the thermocline is located during the summer has been progressively lowered. As a result, temperatures at 20 meters have increased up to 13 C over preoperational levels. This paper describes the distribution and relative abundance of benthos in relation to the heated effluent.

The benthos of Keowee Reservoir is numerically dominated by oligochaetes (52 percent), chironomids (39 percent), and *Chaoborus punctipennis* (6 percent). Of the 18 oligochaete species, naids predominate and are most abundant from 0-10 m. Although 64 chironomids were identified in Keowee Reservoir, only 24 species are common. Abundance of chironomid larvae is greatest from 0-4 m as well as species diversity (max. 30 spp./sample). Spring estimates of generation time (33 days) when projected over the entire growing season would allow 7 generations per year in shallow water. The power plant's thermal plume hastens the emergence pattern of chironomid species occurring within the plume by 2-3 weeks.

76-000348 Kelso, J. R. M. (Fish. Mar. Serv., Great Lakes Biolimnol. Lab., Burlington, ON L7E 4A6, Canada) MOVEMENT OF YELLOW PERCH (*PERCA FLAVESCENS*) AND WHITE SUCKER (*CATOSTOMUS COMMERSONI*) IN A NEARSHORE GREAT LAKES HABITAT SUBJECT TO A THERMAL DISCHARGE. J. Fish. Res. Board Can. 33 (1): 42-53. Jan. 1976. In English with French summ. SFA 21(1).

The thermal discharge from the Nanticoke Generating Station caused both yellow perch (*Perca flavescens*) and white sucker (*Catostomus commersoni*) to increase sharpness of turns, decrease distance between turns, and to orient into the current generated by the discharge. Conversely, fish released in thermally unaffected habitats referenced movement to the shoreline, turned less sharply, and swam greater distances between turns. The tendency for localization of movement was

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increased for both species when in the influence of the discharge. Swimming speeds were less for fish encountering the discharge; however, these fish had to contend with currents generated by the effluent thus making comparisons anomalous. Exposure of fish to elevated temperatures was brief and ranged from a few excursions into thermally elevated areas to approximately 9 h. Fish transplanted from unaffected areas to the discharge area showed behavior similar to fish caught and released at the discharge site. Two fish tracked when cooling water was discharged at ambient temperature suggested that current had a role in causing the observed changes in behavior.

76-000349 Kromrey, G.; Boxrucker, J.; Mills, D.; Morgan, B.; Nebrija, E.; Young, J. (Lab. Limnol., Univ. Wis., Madison 53706) INVERTEBRATE DISTRIBUTION ALONG A THERMAL GRADIENT IN A POWER PLANT COOLING LAKE. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

The construction of a power plant cooling lake at Portage, Wisconsin, provided a unique opportunity to study the effect of a horizontal thermal gradient upon the abundance and distribution of aquatic macroinvertebrates. Dredge samplers and temperature data collected at weekly intervals from 24 Sept. 1975 to 8 Nov. 1975 were used to quantify the changes in density of 3 groups of invertebrates at 15 stations in the lake. Due to plant shutdown, the thermal gradient was no longer present for the 4-week period from 3 Oct. 1975 to 1 Nov. 1975. The populations of all 3 taxa studied appeared to be influenced by changes in the temperature regime. Catches of Chironomidae were greatest in the warmer portion of the gradient. Plant shutdown was followed by a lakewide decline in catch. The population of *Hyalella azteca* was confined to the coldest stations prior to shutdown. Subsequently, *Hyalella* catches increased. Our data do not indicate a distributional response after the plant resumed operation. When the thermal gradient was present, *Caenis* populations exhibited 2 modes of abundance which was attributed to the presence of more than one species in the lake. Dispersal rates were calculated for *Hyalella* and *Caenis*. Some observations were made on the interaction of temperature and predation by fishes in determining the distribution and abundance of those taxa studied.

76-000350 Lattimore, R. E.; Gibbons, J. W. (Savannah River Ecol. Lab., Drawer E, Aiken, SC 29801) BODY CONDITION AND STOMACH CONTENTS OF FISH INHABITING THERMALLY ALTERED AREAS. Am. Midl. Nat. 95 (1): 215-219. Jan. 1976. SFA 21(1).

Body condition and stomach contents in three species of sunfish (*Centrarchidae*) were compared in natural and thermally influenced streams in South Carolina. The thermal stream was divided for sampling purposes into four zones variously affected by the heated water. Individuals of each species collected from the normal temperature adjacent to the heated water had higher condition factors than those from any other area. Also, the largest individuals collected in the thermal stream were from the area of high temperatures. Large body size may allow tolerance to sudden changes in water temperature. Although higher percentages of the fish from the natural stream had food in their stomachs, their diet was more herbivorous than that of thermal stream fish.

SPORT FISHERY ABSTRACTS

76-000351 Lenat, D. R. (Dep. Environ. Sci. Eng., Univ. N.C., Chapel Hill 27514) EFFECTS OF POWER PLANT OPERATION ON THE BENTHOS OF LAKE HYCO, NORTH CAROLINA. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1)

Littoral and profundal benthic macroinvertebrates were sampled quarterly at 5 stations on Lake Hyco, N. C., to assess the effects of a coal-fired steam station. For most profundal organisms the impact of thermal effluents was limited to the discharge pool area. Comparisons with control areas indicated that chironomidae standing crop was significantly lower in the discharge pool (especially *Chironomus attenuatus*) and *Oligochaeta* standing crop (*Limnodrilus hoffmeisteri*, *Dero nivea*, and *Aulodrilus pigueti*) tended to be higher. A temporarily depression of Chironomidae standing crop also was noted at one other station shortly after the introduction of thermal effluents into this area. *Chaoborus punctipennis*, the dominant profundal organism, was affected over a much wider area of the lake. Power plant currents caused a reduction in *Chaoborus* density at both intake and discharge areas. The distribution of littoral organisms was strongly related to temperature. Standing crop of Chironomidae (all species) and Ephemeroptera (*Hexagenia*) was strongly depressed by thermal discharges. Qualitative data indicated that *Anodonta* was similarly affected. *Oligochaeta* became the littoral dominant in thermally affected areas, although standing crop levels were not greater than those in control areas.

76-000352 Leung, S. S.; Williams, J. C. (Dep. Geol., East. Ky. Univ., Richmond 40475) COMMERCIAL FISHERY INVESTIGATIONS OF THE KENTUCKY RIVER. PART II: WATER AND SILT ANALYSIS. Ky. Dep. Fish Wildl. Resour. Proj. No. 2-186-R, Job. 3. viii + 77p. Jan. 1975. SFA 21(1).

Chemical analysis of water samples from the Kentucky River indicates seasonal trends in certain chemical elements. Magnesium and Sulfate concentrations and conductivity show inverse trends while Zinc, Cadmium, Arsenic, Lead, and Mercury show direct relationship to discharge. Copper, Manganese, Iron and Strontium did not show well-defined trends. Surface water quality appears to be degraded in the upstream portion near coal mining areas. The highest concentration of heavy metals were found in the clay-size fraction of sediment. This is probably due to particle size and mineralogy of this fraction. No relationship between heavy metals and stream discharge was noted.

76-000353 MacGregor, J. S. (NMFS, La Jolla Lab., La Jolla, CA 92038) DDT AND ITS METABOLITES IN THE SEDIMENTS OFF SOUTHERN CALIFORNIA. NOAA Fish Bull. 74 (1): 27-35. Jan. 1976. SFA 21(1).

To assess the degree of DDT contamination in the marine sediments off Los Angeles, 103 stations in the Pacific Ocean off southern California were sampled in July and August 1971 for DDT and its metabolites, DDD and DDE. Heavy contamination of bottom sediments in this area was expected because of large amounts of DDT that have entered the ocean through the Los Angeles County sewer system as waste from a DDT manufacturing plant.

From the data acquired, it was estimated that there were about 200 metric tons of DDT, DDD, and DDE in the sediments in an area of 14 square nautical miles near the sewer outfalls and 300 metric tons in the entire 911 square nautical mile area sampled. The heaviest concentrations of total DDT were distributed in the relatively shallow-water area on the Palos Verdes shelf to the northwest of the sewer outfalls in the general direction of the current flow.

Metabolism of DDT was inhibited in deepwater sediments. Ratios of DDE to DDT were low, and DDT was more abundant than DDE at some

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stations. In sediments from shallow-water stations, DDE exceeded DDT by more than 10 times.

76-000354 Maciorowski, A. F.; Benfield, E. F.; Hendricks, A. C. (VPI & SU, Blacksburg, VA 24061) DISTRIBUTION AND ABUNDANCE OF MACROINVERTEBRATES IN THE KANAWHA RIVER, WEST VIRGINIA. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

The Kanawha River has undergone severe degradation due to complex effluent input from municipalities and one of the nation's largest chemical-industrial complexes located near Charleston. The purpose of this study was to examine the distribution and abundance of benthic macroinvertebrates in the river, and to assess the impact of industrial use of the river on the macroinvertebrates. Fourteen sampling sites were selected and placed into three zones based on the amount of industrial activity in the immediate vicinity. Zone I (Stations 1-3) was located upstream of most industries; Zone II (Stations 4-9) was near the center of the South Charleston industrial complex; Zone III encompassed the remaining stations (11-14) and was situated near a second center of industrial concentration near Nitro. While oligochaetes and midge larvae dominated the benthos at all stations, dramatic differences in number of taxa collected, mean density (individuals/m²) and faunal composition were observed. In Zone I, ranges in total taxa and mean density were 23-31 and 1388-1688, respectively. Zone II stations exhibited a marked decrease in mean density (39-425) and a much broader range in total taxa (5-29) as compared to Zone I stations. However, specific stations (7 and 8) in Zone II were very near those in Zone I in terms of total taxa collected. The overall reduction in density at Zone II stations and the reduced number of taxa at certain stations within that zone are attributed to a combination of toxic wastes and habitat disturbance. Stations in Zone III exhibited the broadest range in mean density (13-2586), and a range (10-29) in total taxa comparable to stations in Zone II. Station 13 with a mean density of 2586 individuals/m² reflected extreme organic enrichment while station 14, with a mean density of 13 individuals/m², reflected conditions of extreme toxicity and habitat disturbance.

76-000355 McIay, R. W.; Hundal, M. S.; Lamborn, K. R. (18 Redwood Terrace, Essex Junction, VT 05452) IMPROVING THE STATISTICAL RELIABILITY OF STREAM HEAT ASSIMILATION PREDICTION. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-037. v + 157p. June 1975. SFA 21(1).

In response to an increased interest in water quality by the public, a large effort has been mounted to develop mathematical models for predicting heat assimilation in bodies of water. The accuracy of these models has recently come under scrutiny due to the need for temperature predictions within 1 C of the ambient. This work is an evaluation of existing, one-dimensional stream temperature prediction techniques for accuracy and precision. The approach is through error estimates on a general model that encompasses all of the models presently used. A sensitivity analysis of this general model is used in conjunction with statistical methods to determine the solution errors. Data taken in 1973 at the Vernon, Vermont nuclear plant are used as a data base. These data are used in conjunction with Burlington, Vermont airport weather station data to 1) gain insight into the orders-of-magnitude of the various errors and 2) carry out a detailed data analysis to establish the probabilities of meeting given error requirements. This report contains the model descriptions for the general stream model, the sensitivity analysis model, and the data analysis models; a description of the Vernon, Vermont site; the data

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for four problems from the Vernon nuclear plant; an order-of-magnitude error study; and the results of the four data analyses. The four appendices contain 1) a description of the input FORMAT specifications, 2) the input data for the four problems, 3) program listings, and 4) the theory of the sensitivity analysis.

76-000356 Pagel, C.; Wade, C. (Dep. Water Resour., Montpelier, VT 05602) BENTHIC CHANGES IN A BAY RECEIVING ANNUAL COPPER SULFATE APPLICATIONS IN LAKE CHAMPLAIN. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

In recent years St. Albans Bay has suffered from substantial algal blooms. In an effort to control the problem over 50,000 pounds of copper sulfate have been applied during the past decade. The bay also has enriched bottom sediments as a result of inefficient sewage facilities and a mainly agricultural drainage basin.

During the past ten years there has been a noticeable change in the benthic fauna. The gastropods have decreased from 162/m² in 1966 to 45/m² in 1975. On the other hand the Chironomidae have experienced a six-fold increase.

The Oligochaeta have maintained stable numbers, however there has been a dramatic change in their community structure. *Pelosclex ferox* was dominant in 1966, but during the 1975 sampling period immature capilliform specimens and *Limnodrilus hoffmeisteri* were considerably more abundant. Many other changes in species composition of the benthic community were noted.

76-000357 Pearson, F. H.; McDonnell, A. J. (Land Water Res. Inst., Pa. State Univ., University Park) LIMESTONE BARRIERS TO NEUTRALIZE ACIDIC STREAMS. Proc. Am. Soc. Civ. Eng., J. Environ. Eng. Div. 101 (EE3): 425-440. June 1975. SFA 21(1).

Water sample analyses and field measurements were collected over a 9-month period at four prototype limestone barriers to determine barrier performance. These data demonstrate the capability of properly designed barriers to renovate acidic streams for many economic uses, and to support normal aquatic life.

To rationalize the design of barriers, a mathematical model was constructed of barrier performance, comprising hydraulic laws and the chemical kinetics of the rate limiting reactions.

Comparisons of model prediction with prototype performance indicates that a coating of clay, or of metal hydroxides from mine drainage, reduces the reactivity of crushed limestone by a factor of five. Where the bed of crushed limestone becomes clogged by silt or by metal hydroxides, the stone becomes ineffective since it is inaccessible to the flowing acidic water, except that the top layer of stone remains reactive.

There was little exsolution of carbon dioxide within the limits of the barriers studied, which simplifies barrier design.

Based on the results of the evaluation of the processes that operate in the prototype limestone barriers, a procedure was developed for the rational design of barriers. Graphs are provided from which the quantity of crushed limestone that is required to neutralize a stream can be determined, and for determination of the rate of dissolution of limestone in the acidic stream. The conditions for avoiding either the washout of stone from a barrier during floods, or the clogging of interstices within the stone by sediment are presented graphically. From the design conditions a complete barrier design can be rapidly prepared. (Auth. Summ. and Concl.)

76-000358 Platts, W. S.; Megahan, W. F. (U.S. Forest Serv., Intermt. For. Range Exp. Stn., 507 25th St., Ogden, UT 84401) TIME TRENDS IN RIVERBED SEDIMENT COMPOSITION IN SALMON AND STEELHEAD SPAWNING AREAS: SOUTH FORK SALMON RIVER, IDAHO. Trans. N. Am. Wildl. Nat. Resour. Conf. 40: 229-239. 1975. SFA 21(1).

Describes the trends in river channel materials in four major summer chinook salmon and steelhead trout spawning areas over an eight-year period. In 1966 accelerated sand deposits from past logging operations had increased in the river channel by 350 percent over pre-logging conditions. The sediment severely damaged the spawning areas, burying them under thick blankets of sand. Since 1966 to date the spawning materials have been steadily improving in quality.

76-000359 Powell, H. B.; Williams, J. C. (Dep. Chem., East. Ky. Univ., Richmond 40475) COMMERCIAL FISHERY INVESTIGATIONS OF THE KENTUCKY RIVER. PART III: FISH AND MUSSEL TISSUE ANALYSIS. Ky. Dep. Fish Wildl. Resour. Proj. No. 2-186-R, Jobs 4 & 5. iv + 43p. Jan. 1975. SFA 21(1).

The heavy metals, Cadmium, Copper, Lead, Manganese, Mercury and Strontium were accumulated in clam shells whereas the small ions of Iron, Magnesium and Zinc were not. In the soft tissues, finfishes were higher in Cadmium, approximately equal in Magnesium and lower in Copper, Iron, Manganese, Strontium and Zinc when compared to the soft tissues of clams. The delaminated clam shells exhibited a variation from lamina to lamina indicating a difference in concentration in the water for various years. Additional work needs to be done to determine the relationship of these shell concentrations with continuously monitored water quality. No pesticides or herbicides in detectable

76-000360 Ruess, J. O. (Natl. Environ. Res. Cent., 200 SW 35th St., Corvallis, OR 97330) CHEMICAL/BIOLOGICAL RELATIONSHIPS REVELANT TO ECOLOGICAL EFFECTS OF ACID RAINFALL. U.S. Environ. Prct. Agency Ecol. Res. Ser. EPA-660/3-75-032. iv + 46p. June 1975. SFA 21(1).

This paper deals with problems concerning measurements of rainfall acidity and interpretation in terms of possible effects on the soil-plant system.

The theory of acidity relationships of the carbon dioxide-bicarbonate equilibria and its effect on rainfall acidity measurements is given. The relationship of a cation-anion balance model of acidity in rainfall to plant nutrient uptake processes is discussed, along with the relationship of this model to a rainfall acidity model previously proposed in the literature. These considerations lead to the conclusion that average H^+ concentration calculated from pH measurements is not a satisfactory method of determining H^+ loading from rainfall if the rain is not consistently acid. Calculating loading from H^+ minus HCO_3^- , strong acid anions minus basic cations, or net titratable acidity is suggested.

The flux of H^+ ions in soil systems due to plant uptake processes and sulfur and nitrogen cycling is considered. H^+ is produced by oxidation of reduced sulfur and nitrogen compounds mineralized during decomposition of organic matter. Plant uptake processes may result in production of either H^+ or OH^- ions. Fluxes of H^+ from these processes are much greater than rainfall H^+ inputs, complicating measurement and interpretation of rainfall effects. The soil acidifying potential due to the oxidation of the NH_4^+ in rainfall is examined, with the conclusion that acidity from this source is of a similar magnitude to direct H^+ inputs common in rainfall.

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76-000361 Schlueter, R. A. EFFECTS OF THERMAL EFFLUENTS ON REPRODUCTION OF MINNOWS IN THE WHITE RIVER, INDIANA. Ph.D. dissertation, Ind. State Univ. 61p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(7), 1976. SFA 21(1).

The findings of this study suggest that the present influx of heated water discharge to the study area does not significantly alter the gonad development of the minnows investigated. However, temperature is suggested as affecting the number of reproductive adults present in the heated and unheated areas. Also the increase in temperature may cause earlier spawning in heated areas. (From Auth. Abstr.)

76-000362 Stauffer, J. R., Jr. THE INFLUENCE OF TEMPERATURE ON THE DISTRIBUTION, COMMUNITY STRUCTURE AND CONDITION OF FISH OF THE NEW RIVER, GLEN LYN, VIRGINIA. Ph.D. dissertation, Va. Polytech. Inst. & state Univ. 249p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(3), 1975. SFA 21(1).

The total effects of the heated discharge on fish community structure was regarded as minimal. It was possible to determine a final temperature preference from the field data and relate this information to laboratory responses. Three basic types of responses to temperature were demonstrated: 1) species which avoided high temperatures; 2) species which were attracted to high temperatures; and 3) species which had a distribution apparently unaffected by temperature. It was determined that a comparison in internal body temperatures with water temperatures was not a valid method of estimating residency time. Finally, it was shown that catfish taken from the heated discharge had different material in their stomachs than did those from non-heated areas. The heated discharge also significantly lowered the condition factors of most species tested. Overall it was demonstrated that the thermal discharge did not disrupt the fish community's structure and function. (From Auth. Abstr.)

76-000363 Stiefel, R. C. (Water Resour. Cent., Coll. Eng., Ohio State Univ., Columbus 43210) MERCURY AS A FACTOR IN THE FISHERIES ENVIRONMENT. Ohio Dep. Nat. Resour., Div. Wildl. 45p. 1975. SFA 21(1).

The results of the analyses for the total mercury concentration in the fillets of over 3900 fishes included in over 1500 samples collected from 195 locations distributed throughout the State of Ohio indicate that while there is some mercury in nearly every fish tested, there are only a few species of fishes from a limited number of locations throughout the State that contain excessive concentrations of mercury.

Only 128 of the 1537 samples analyzed contained mercury in concentrations above 0.5 milligrams per kilogram; and fully one-third of these samples were collected from one river basin and at one other location in the State.

The species of fishes that contain high mercury concentrations are generally the larger specimens of the predator fishes, although some forage fishes occasionally accumulate mercury.

Based on these results, it has been concluded that mercury contamination is not a serious problem in the fisheries environment in the State of Ohio.

76-000364 van der Leeden, F.; Cerrillo, L. A.; Miller, D. W. (Geraghty & Miller, Inc., Port Washington, NY) GROUND-WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-018. xiv + 361p. May 1975. SFA 21(1).

An evaluation of ground-water contamination problems has been carried out in six states in the northwest: Colorado, Idaho, Montana, Oregon, Washington and Wyoming. Ground-water supplies 12 percent of the total water withdrawn in the region, with the major pumpage in Colorado and Idaho. Industrial and agricultural growth and development of new energy sources will cause a sharp increase in ground-water use over the next 30 years.

Natural ground-water quality varies widely. Saline ground water underlies more than half of Colorado, Montana and Wyoming. In the mountainous areas, and in the more humid sections of Idaho, Washington and Oregon, the quality of ground water is generally good to excellent. The most common natural ground-water quality problems, other than high salinity, are excessive hardness, iron, manganese, and fluoride. Principal sources of man-caused ground-water quality problems in the approximate order of severity are: discharge of effluent from septic tanks and sewage treatment plants, irrigation return flow, dryland farming, abandoned oil wells, shallow disposal wells, unlined surface impoundments, mine tailings and mine drainage, municipal and industrial landfills, and radioactive waste disposal. Other sources that appear to be of less importance but still must be considered include: spills and leaks, application of fertilizers and pesticides, feedlots, and salt-water intrusion.

The findings of the investigation indicate that, with the exception of radioactive waste disposal, few cases of ground-water pollution have been investigated in detail. There is a need for baseline water-quality data and systematic evaluation of overall ground-water conditions, especially in urban zones, in areas of petroleum exploration and development, and at locations of mining and industrial activity.

76-000365 Wentzel, R. S.; McIntosh, A. W. (Bionucleon. Dep., Purdue Univ., West Lafayette, IN 47906) DISTRIBUTION OF BENTHIC MACROINVERTEBRATES IN A METAL-CONTAMINATED LAKE. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

Palestine Lake, Palestine, Indiana, is a state-owned lake of approximately 232 acres with an average depth of four feet. One of the four ditches feeding the lake contains electroplating plant effluents with high levels of cadmium, chromium and zinc.

Benthic organisms were sampled from June to November 1975 at different sites in Palestine Lake representing areas of both high and low levels of metal contamination. The variation in the different populations was noted. Chironomids and oligochaetes were the dominant organisms with oligochaetes found in high numbers near the mouth of the ditch and chironomids largely absent from areas of highest contamination.

Sediment samples were also taken at each site and analyzed for metals and other parameters. The maximum levels from metals were 1000 ppm cadmium, 15,000 ppm zinc, and 2100 ppm chromium near the ditch. The minimum levels were 2 ppm cadmium, 167 ppm zinc, and 76 ppm chromium in a relatively unpolluted area distant from the ditch.

Lab studies are being conducted to determine why the populations vary at different sites.

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76-000366 Westlake, G. F.; van der Schalie, W. H.; Cairns, J., Jr.; Dickson, K. L. (Biol. Dep., VPI & SU, Blacksburg, VA 24061) THE USE OF FISH TO CONTINUOUSLY MONITOR AN INDUSTRIAL EFFLUENT. Inst. Electr. Electron. Eng. Inc. Ann. No. 75CH1004-1 18-4. 3p. 1976. SFA 21(1).

In order to detect developing toxic conditions in industrial waste discharges, a fully automated biological monitoring system using sublethal responses of fish has been developed. The installation and operation of this system at an industrial site are discussed. Data gathered continuously from the fish at the industrial site are analyzed by a small computer which automatically produces alarms at the site should toxic conditions appear to be developing. (Auth. Summ.)

TOXICOLOGY; BIOASSAYS

76-000367 Adelman, I. R.; Smith, L. L., Jr.; Siesennop, G. D. (Dep. Entomol., Fish. Wildl., Univ. Minn., St. Paul 55108) ACUTE TOXICITY OF SODIUM CHLORIDE, PENTACHLOROPHENOL, GUTHION, AND HEXAVALENT CHROMIUM TO FATHEAD MINNOWS (*PIMEPHALES PROMELAS*) AND GOLDFISH (*CARASSIUS AURATUS*). J. Fish. Res. Board Can. 33 (2): 203-208. Feb. 1976. In English with French summ. SFA 21(1).

The 96-h LC50's for sodium chloride were 7650 and 7341 mg/liter, for pentachlorophenol 0.21 and 0.22 mg/liter, for Guthion 1.9 and 2.4 mg/liter, and for hexavalent chromium 48 and 120 mg/liter, for fathead minnows (*Pimephales promelas*) and goldfish (*Carassius auratus*), respectively. Threshold LC50's were reached in 6 days for sodium chloride (7650 and 7322 mg/liter for fathead minnows and goldfish, respectively), and pentachlorophenol (0.21 and 0.21 mg/liter), but were not attained in 11 days (termination of testing) with Guthion (0.76 and 0.80 mg/liter) and hexavalent chromium (18 and 33 mg/liter). With pentachlorophenol and Guthion goldfish were initially more resistant, but by termination there was no significant difference in LC50's between the two species. With hexavalent chromium the goldfish were more resistant throughout the 11-day test, and with sodium chloride goldfish were initially more resistant but at attainment of a threshold LC50 were less resistant. Use of toxicity curves for assessment of acute mortality permits interpretation not possible in 96-h tests where LC50's are computed at 24-h intervals.

76-000368 Adelman, I. R.; Smith, L. L., Jr. (Dep. Entomol. Fish. Wildl., Univ. Minn., St. Paul 55108) FATHEAD MINNOWS (*PIMEPHALES PROMELAS*) AND GOLDFISH (*CARASSIUS AURATUS*) AS STANDARD FISH IN BIOASSAYS AND THEIR REACTION TO POTENTIAL REFERENCE TOXICANTS. J. Fish. Res. Board Can. 33 (2): 209-214. Feb. 1976. In English with French summ. SFA 21(1).

Fathead minnows (*Pimephales promelas*) and goldfish (*Carassius auratus*) were compared for their suitability as standard bioassay fish. Both species showed the same variability of bioassay results when tested with four toxicants. Fathead minnows are recommended on the basis of their small size and on their capability for use in complete life cycle tests.

On the basis on minimum variability of bioassay results, sodium chloride was superior for use as a reference toxicant. Both sodium chloride and pentachlorophenol seemed capable of detecting abnormal fish. On the basis of seven listed criteria either sodium chloride or pentachlorophenol would be acceptable as a reference toxicant.

76-000369 Authur, J. W.; Andrew, R. W.; Mattson, V. E.; Olson, D. T.; Glass, G. E.; Halligan, B. J.; Walbridge, C. T. (U.S. EPA, Environ. Res. Lab., Duluth, MN 55804) COMPARATIVE TOXICITY OF SEWAGE-EFFLUENT DISINFECTION TO FRESHWATER AQUATIC LIFE. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-600/3-75-012. ix + 61p. Nov. 1975. SFA 21(1).

Flow-through laboratory bioassays were conducted with a domestic secondary sewage effluent that had been disinfected by chlorination, by chlorination followed by dechlorination, and by ozonation. Effluent without disinfection served as a control. Disinfection with chlorine and ozone generally maintained the effluent at total coliform levels of less than 1,000 per 100 ml. Lake Superior water served as the diluent source for the experiments. Short-term (7-day) exposures were conducted with 13 species (seven fish and six invertebrates), and long-term (generation) tests were performed with three species (one fish and two invertebrates). In both series of tests the chlorinated effluent was lethal at appreciably lower concentrations than any of the other three effluent treatments. Fish were more sensitive than the invertebrates to the chlorinated effluent in 7-day tests. The respective 7-day TL50 values of total residual chlorine to fish and invertebrates ranged from 0.08 to 0.26 to greater than 0.81 mg/l. Residual ozone rapidly decreased in the treated effluent and was not measurable in the test tanks. When special short-term test procedures and shorter retention times for the ozonated effluent were used, measured residual ozone was about as lethal to fathead minnows as residual chlorine. The highest mean total residual chlorine concentrations having no long-term adverse effect on fathead minnows, amphipods, and *Daphnia* were 14, 12, and 2-4 ug/l., respectively. No daphnids survived at approximately 10 ug/l. mean total residual chlorine, a concentration that corresponds to a chlorinated sewage concentration of about 2.5 percent. Residual sulfite at the concentrations used to neutralize the chlorine residual dissipated readily and had no measurable adverse effect on the species tested.

76-000370 Berg, A.; Brazzelli, A. (CCR-EURATOM, 21020 Ispra (Varese), Italy) ETUDE EXPERIMENTALE DU TRANSFERT DU ^{65}Zn A UN POISSON D'EAU DOUCE AVEC REFERENCE PARTICULIERE AUX DEUX VOIES D'ABSORPTION ET AU METABOLISME DE L'ELEMENT STABLE. [EXPERIMENTAL STUDY OF THE TRANSFER OF ^{65}Zn TO A FRESHWATER FISH WITH PARTICULAR REFERENCE TO THE TWO PATHS OF ABSORPTION AND THE METABOLISM OF THE STABLE ELEMENT.] Radioprotection 10 (2): 61-84. 1975. In French with English summ. SFA 21(1).

The use of ^{65}Zn as a tracer allows the determination of important parameters of zinc metabolism (rates of direct and intestinal retention, turnover coefficient). Because of the very low value of the latter parameter (around 0.3 p. cent/day), the equilibrium state cannot be estimated from a short term experiment.

In the fish species studied (*Carassius auratus* L.), direct absorption contributes more than intestinal absorption in the total retention rate and can probably alone fulfill the total zinc requirements of the fish. The total retention rate, together with the total Zn content, are subject to homeostatic regulation, thus indicating the metabolic role of the element zinc. It follows that direct accumulation of radiozinc is inversely proportional to zinc concentration in water (as the ion Zn^{++}). Similarly the intestinal accumulation of radiozinc is inversely proportional to the dose of ingested zinc. The low turnover coefficient is responsible for the very slow rate of excretion of previously absorbed radiozinc.

The radiocological implications of this study of zinc metabolism are underlined. The danger of cumulative concentration of radioactivity through ingestion of highly radioactive food is neutralized by the processes of metabolic regulation. One must be particularly careful in drawing conclusions about the equilibrium

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level of radioaccumulation because of the low turnover of the element.

76-000371 Berg, A. R.; Weiss, G. M. (CCR-EURATOM, 21020 Ispra (Varese), Italy) LE TRANSFERT DU ZINC-65 DE SEDIMENTS A DES LARVES DE CHIRONOMIDES ET A UN POISSON D'EAU DOUCE ET L'EFFET DU CADMIUM SUR CE TRANSFERT. [TRANSFER OF ZINC-65 FROM SEDIMENTS TO CHIRONOMID LARVAE AND TO A FRESHWATER FISH AND THE EFFECT OF CADMIUM ON TRANSFER.] In Impacts of Nuclear Releases into the Aquatic Environment. Int. Atomic Energy Agency IAEA-SM-198/47. 121-132. 1975. In French with English summ. SFA 21(1).

This transfer was studied by equilibrating--in the presence of ^{109}Cd --a sediment rich in organic matter with water from Lake Maggiore in three different cadmium concentrations (0, 10, and 20 pp 10%). The chironomid larvae reared on this sediment were then used as 'natural' food for a small tropical fish (*Haplochromis burtoni*), kept in an aquarium at these same concentrations of cadmium in the water. The transfer of radiozinc and radiocadmium was traced over various links of the ecological chain (sediment-water-larvae-fish). The results indicate that cadmium strongly inhibits the exchange of zinc for the larvae. This inhibition must constitute a significant sublethal effect on a population of benthic organisms of considerable ecological importance. In the case of the fish, however, this inhibition is not apparent at the cadmium concentrations employed. Branchial absorption plays a predominant role, compared with intestinal absorption, for both radiozinc and radiocadmium. While the equilibration time for the accumulation of radiozinc by the fish is very long, the cadmium accumulation reaches equilibrium rapidly (5-7 days). On the other hand, the excretion of the accumulated cadmium takes place at a relatively slow rate.

76-000372 Borton, D. L. EFFECTS OF PRIMARY TREATED AND BIOLOGICALLY STABILIZED KRAFT MILL EFFLUENTS ON THE PRODUCTION, BIOMASS AND GROWTH RATES OF JUVENILE SALMONIDS IN THREE STREAM CHANNELS. Ph.D. dissertation, Oreg. State Univ. 95p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

Three stream channels, 100 meters long and 2 meters wide with 11 riffles and 11 pools, received 12.7 liters per second each of dilution water pumped from the Willamette River during the entire experimental period. Primary KME from the settling lagoon of an Oregon pulp mill entered one of the streams at a rate of 0.75 mg per liter BOD during experimental periods I, and II from January 2, 1970 to March 12, 1971. Biologically stabilized KME from the aeration lagoon of the pulp mill entered stream 2 at 0.75 mg per liter BOD during experimental periods III, IV, V, and VI from March 16, 1971 to January 30, 1973.

There was no effect on the production of salmonids when primary KME entered stream 2 at 0.75 mg per liter BOD. For very brief periods, however, the effluent became very toxic to the fish and on two occasions fish kills occurred. After restocking, the production of salmonids in the stream receiving effluent was nearly equal to that of the control stream channels. The production of salmonids in the stream channel receiving biologically stabilized KME was not noticeably affected. Results of the stomach content analysis, along with insect benthic biomass data provided by Richard E. Craven (MS) at times indicated there was a relationship between the growth rate of salmonids in each stream and the benthic biomass of the principal food organisms in the stream.

Comparison between the production rates of salmonids on these stream channels to the production rates of salmonids in similar experiments revealed that the productivity of the three stream channels was generally high. (From Auth. Abstr.)

76-000373 Bourquin, A. W. (Gulf Breeze Environ. Res. Cent., Sabine Island, Gulf Breeze, FL 32561) MICROBIAL-MALATHION INTERACTION IN ARTIFICIAL SALT-MARSH ECOSYSTEMS. EFFECT AND DEGRADATION. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-035. vi + 41p. June 1975. SFA 21(1).

Malathion is rapidly degraded *in vitro* by salt-marsh bacteria to malathion-monocarboxylic acid, malathion-dicarboxylic acid and various phosphothionates as a result of carboxyesterase cleavage. In addition, some expected phosphatase activity produces desmethyl-malathion, phosphothionates, 4-carbon dicarboxylic acids, and corresponding ethyl esters.

In a simulated salt-marsh environment, malathion is degraded by the indigenous bacterial community. Numbers of bacteria capable of degrading malathion in the presence of additional nutrients increase in the sediments with increasing frequency of application and in the water column with the increasing level of treatment. Numbers of bacteria which degrade malathion as a sole carbon source are linked to the level of treatment in sediments and the frequency of treatment in the water column; however, these bacteria do not appear to play a significant role in the dissipation of malathion. I believe that frequency of treatment, increases numbers of malathion co-metabolizing bacteria which catalyze a more rapid dissipation of the compound, which results in fewer sole carbon degraders.

The disappearance of malathion in the salt-marsh environment is influenced by both chemical and biological degradation; however, at temperatures below 26 C and salinities below 20‰, chemical mechanisms appear to be of less importance than biological degradation.

76-000374 Brenniman, G. R. UPTAKE, DISTRIBUTION AND EFFECTS OF OUTBOARD MOTOR EXHAUST EMISSIONS ON GOLDFISH (*CARASSIUS AURATUS*). Ph.D. Dissertation, Univ. Mich. 201p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. SFA 21(1).

Continuous flow bioassays were run for 24, 48, 72, and 96 hours so that the lethal concentration for 50 percent of individuals (LC-50's) could be determined for leaded OME, non-leaded OME, toluene, xylene, and 1,3,5 trimethylbenzene. The 96-hour LC-50's for the above exhaust components were found to be 171, 168, 23, 17, and 13 parts per million (ppm), respectively. The values of 171 and 168 ppm are given in terms of gallons of fuel burned per million gallons of water.

Fish exposed to varying concentrations of OME water and toluene showed a highly significant drop in blood $p(O_2)$ and a significant increase in blood $p(CO_2)$. This phenomenon was attributed to difficulty in transporting oxygen across the gill membranes. Carbon monoxide from outboard motors did not cause any significant problems for the fish. The histopathological studies of fish, which had been exposed to leaded OME water and toluene for 720 hours, revealed varying degrees of cellular damage in the gills, liver, and kidneys. Other findings from the 720-hour tests revealed that the gall bladder to body weight ratios and the hippuric acid concentrations were statistically higher in the experimental fish.

Toluene, as a representative aromatic hydrocarbon, was studied in additional detail. Fish that were exposed to C^{14} toluene in water under static conditions from 24 hours showed maximum uptake after 12 hours exposure. Toluene concentrations of approximately 560 ppm/g were found in the whole fish after being exposed for 12 hours, while the water contained 40 ppm toluene/ml. The clearance half-lives of C^{14} toluene from the whole fish after 12, 6, and 2 hours exposure were estimated to be 4.07, 3.89, and 2.67 hours, respectively. C^{14} toluene was found to be distributed in greatest concentrations in the brain (570 ppm/g), gall bladder (740 ppm/g), liver (360 ppm/g), and kidneys

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(430 ppm/g). Lesser concentrations were found in the stomach and small intestine (305 ppm/g), spleen (300 ppm/g), and gills (260 ppm/g). Although goldfish have the ability to store toluene in concentrations greater than that found in water, biological accumulation of toluene under natural conditions is not likely to be a problem, because no effects were noted at levels considerably above these which might be encountered in the environment.

It was concluded from the above data that toluene can enter readily into the systems of the fish, be distributed throughout several compartments, and be cleared in a relatively short time. Furthermore, concentrations of OME emissions used in this study to achieve the above effects were much higher than one realistically finds in natural conditions. Therefore, it seems that outboard motor exhaust is not implicated in acute toxicity to fish. Finally, the relatively rapid clearance of C¹⁴ toluene from fish makes it unlikely that a health hazard to man exists from this and closely related aromatic hydrocarbons from OME emissions. (From Auth. Abstr.)

76-000375 Brown, L. R.; Alley, E. G.; Cook, D. W. (Miss. State Univ., Mississippi State 39762) THE EFFECT OF MIREX AND CARBOFURAN ON ESTUARINE MICROORGANISMS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-024. vii + 47p. June 1975. SFA 21(1).

The purpose of this investigation was to help establish the chemical, physical and microbiological fate of mirex and carbofuran in the estuarine environment and determine the effect(s) on important estuarine microorganisms and their activities. Chemical studies on the adsorption, fate and hydrolysis were conducted. The microbiological studies involved the use of both pure cultures and mixed cultures in a microcosm system and included twelve distinct physiological groups of microorganisms.

It was concluded that neither mirex nor carbofuran would have a deleterious effect of estuarine bacteria under normal conditions, and there was no evidence of bioaccumulation. Degradation products of both compounds were shown to be toxic to some microorganisms.

76-000376 Buikema, A. L. Jr.; Lee, D. R.; Cairns, J., Jr. (Dep. Biol., VPI & SU, Blacksburg, VA 24061) A SCREENING BIOASSAY USING /DAPHNIA PULEX/ FOR REFINERY WASTES DISCHARGED INTO FRESHWATER. J. Test. Mater. 4 (2): 119-125. Mar. 1976. SFA 21(1).

A simple method using unsophisticated equipment is suggested for on-site toxicity testing of refinery effluents. This method will provide an inexpensive means of identifying problem materials and establishing priorities for coping with these materials. An arbitrary reference mixture, containing six common constituents of refinery wastewaters, was used for static toxicity tests on 15 species of freshwater invertebrates and 3 species of fish. /Daphnia pulex/ was selected for further testing because it was the most sensitive of the animals tested, relatively inexpensive and easy to maintain, and a potential fish-food organism. If the reference mixture were representative of a refinery effluent, the /Daphnia/ bioassay would be sufficiently sensitive to give reliable results within 48 h, whereas a fish bioassay would show no toxicity even after 96 h.

To assess the suitability of the /Daphnia/ bioassay, tests were conducted by personnel at six petroleum refineries. Duplicate tests were in agreement. Results of tests using actual refinery effluents ranged from no toxicity after 96 h to a mean lethal concentration of 1.2 percent effluent after 48 h. The data presented show that the method was reproducible and that refinery personnel were able to perform the bioassay. Potential problems and advantages of the method are discussed.

76-000377 Buress, R. M. (Southeast. Fish Control Lab., Warm Springs, GA) DEVELOPMENT AND EVALUATION OF ON-SITE TOXICITY TEST PROCEDURES FOR FISHERY INVESTIGATIONS. U.S. Fish Wildl. Serv. Invest. Fish Control 68. 8p. 1975. SFA 21(1).

A simple, inexpensive procedure was developed for conducting on-site tests (bioassays) of the toxicity of various concentrations of antimycin on target and nontarget fishes in waters to be treated. After preliminary laboratory experiments with seven types of containers showed that large polyethylene bags were best for use in field toxicity tests, year-round field experiments were performed in ponds. Measurements of water quality in large bags containing 284 liters of water were closely similar to water quality measurements in ponds throughout the test periods. The maximum safe loading level for 96-h tests at temperatures above 18.3 C was about 852 g of fish per bag, but this amount could be increased in colder water or in shorter tests. Final modifications and evaluations of the method were made on the basis of treatments of ponds with antimycin in accordance with data derived from on-site tests. The procedure described is adaptable for tests of many other chemical compounds commonly used by fishery workers.

76-000378 Currier, J. B. WATER QUALITY EFFECTS OF LOGGING RESIDUE DECOMPOSITION FROM LODGEPOLE PINE. Ph.D. dissertation, Colo. State Univ. 166p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(8), 1975. SFA 21(1).

Chipped residue from a lodgepole pine clearcut was collected and leached in the laboratory to determine the quantity and composition of the extractable compounds. The major objective of the study was to determine if the leached compounds would adversely affect water quality. The leachate generated was analyzed and used in bioassays.

The leachate consisted primarily of carbohydrates, phenolics, and mineral salts. The carbohydrates were rapidly utilized by microbial organisms and removed from solution; consequently the leachate consisted primarily of phenolics. The principal component among the phenolic compounds was tannin. The mineral salts comprised approximately 15 percent of the extracted material.

Decomposition and percolation tests with the leachate showed that approximately 50 percent of the phenolics would decompose within 96 hours. The rate of decomposition was influenced by temperature and aeration of the water. A 16 C increase in temperature resulted in a fourfold reduction of phenolic activity. Aerated solutions showed a twofold reduction of phenolic activity when compared to non-aerated solutions. Passage of the leachate through soil cores resulted in approximately 50 percent reduction in phenolic activity due to decomposition and attachment of the phenolics to soil particles.

Bioassays using stonefly and mayfly nymphs subjected to concentrations as high as 80 mg/l of phenolic activity resulted in a maximum of only 20 percent mortality. Rainbow trout were tested at three ages, ranging from three days to eight weeks after hatching. The bioassays produced a TL(m) in excess of 50 mg/l of phenolic activity. The maximum concentration that could be expected under natural conditions was estimated to be less than 40 mg/l of phenolic activity.

Results of this study indicate that in general organic compounds leached from wood chips, bark, and needles will not adversely affect water quality.

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76-000379 Environmental Protection Agency (Research Triangle Park, NC 27711) SCIENTIFIC AND TECHNICAL ASSESSMENT REPORT ON CADMIUM. U.S. Environ. Prot. Agency Star Ser. EPA-600/6-75-003. viii + 59p. July 1975. SFA 21(1).

This report is a review and evaluation of the current knowledge of cadmium in the environment as related to possible deleterious effects on human health and welfare. Sources, distribution, measurement, and control technology are also considered. Cadmium is widely distributed in the environment. The air over urban areas has contained generally less than 0.1 microgram per cubic meter ($\mu\text{g}/\text{m}^3$), 24-hour average, but a 24-hour average as high as 0.73 $\mu\text{g}/\text{m}^3$ has been measured in the air of a community with a known cadmium source. The cadmium content of water generally is less than 1 part per billion although much higher values have been found. The cadmium content in foods varied widely. The estimated intake from foods is 25 to 75 micrograms per day. The human body burden of cadmium is cumulative. The half-time of cadmium in man is estimated at over 10 years. Man's primary exposure is from food, tobacco smoke, water, and ambient air. Food and tobacco smoke are the major sources except in the immediate vicinity of major sources of atmospheric emissions of cadmium. Emphysema and other lung diseases have been related to industrial exposure to airborne cadmium compounds. Kidney damage has also resulted from long-term exposure to cadmium. Animal experiments link anemia, hypertension, testicular necrosis, and carcinogenesis with cadmium exposure. Current knowledge of the dose-response relationship does not provide criteria on which to base standards.

76-000380 Environmental Protection Agency (Research Triangle Park, NC 27711) SCIENTIFIC AND TECHNICAL ASSESSMENT REPORT ON MANGANESE. U.S. Environ. Prot. Agency Star Ser. EPA-600/6-75-002. viii + 57p. Apr. 1975. SFA 21(1).

This report is a review and evaluation of the current knowledge of manganese in the environment as related to possible deleterious effects on human health and welfare. Sources, distribution, measurement, and control technology are also considered. Manganese is associated with small particles in the air. Concentrations measured in ambient air averaged 0.1 $\mu\text{g}/\text{m}^3$ (annual) with a maximum of 8.3 $\mu\text{g}/\text{m}^3$ (annual) near a large source.

In Norway, a form of pneumonia was attributed to airborne manganese in a community where concentrations were measured at 46 $\mu\text{g}/\text{m}^3$. Manganese poisoning characterized by progressive central nervous system deterioration has occurred under occupational exposure but apparently not from atmospheric exposure. Control of fine particulate emissions should reduce manganese emissions considerably.

76-000381 Gregg, B. C. THE EFFECTS OF CHLORINE AND HEAT ON SELECTED STREAM INVERTEBRATES. Ph.D. dissertation, Va. Polytech. Inst. & State Univ. 322p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(1), 1975. SFA 21(1).

Organisms in receiving waters are exposed to the toxic effects of chlorine and part of this research was a study of the dosage mortality (LC(50)) and time-mortality (LT(50)) of intermittent and of continuous chlorine exposures at 6°, 15°, 25°, and 32°C. Tests were conducted by placing various stream invertebrate species in fiberglass mesh baskets in stainless steel artificial streams. Species tested included mayflies, snails, an isopod, an amphipod, a caddisfly, stonefly, and an aquatic beetle. The mayfly species were among the most sensitive to both types of chlorine dosing, while the caddisfly and beetle were the most resistant. The operculate snails were more sensitive to continuous than intermittent exposures, because under the latter conditions they were able to withdraw into their shells, closing their

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opercula to avoid contact with the chlorinated waters. Most organisms were more sensitive to chlorine at higher temperatures, but some species exhibited the same sensitivity at 32°C as at 6°C. Smaller organisms were more sensitive to chlorine than larger individuals. Tests indicated that most continuous LC(50)'s were intermediate between the intermittent peak (highest concentration of the chlorine cycle) and mean (average concentration during cycle) LC(50)'s. LT(50)'s

for organisms exposed to an intermittent mean and peak concentration were intermediate between LT(50)'s for two similar continuous concentrations.

The other part of this research was conducted with mayflies, a stonefly, and a snail to determine the toxicity of entrainment type exposures. Higher shock temperatures caused more rapid mortality and organisms acclimated to higher temperatures were more heat tolerant. There was no difference in thermal resistance between small and large individuals. In tests with heat plus chlorine shocks, there was "no effect" of added chlorine at higher shock temperatures, but at lower shock temperatures there was a "potentiation" of the joint action of chlorine and heat. Suggestions are made for minor changes in power plant operation to minimize their effects on the aquatic environment. (From Auth. Abstr.)

76-000382 Haagsma, J. (Cent. Vet. Inst., Rotterdam, The Netherlands) SENSITIVITY OF EELS (*ANGUILLA ANGUILLA*) AND CARP (*CYPRINUS CARPIO*) TO TYPE C AND E BOTULINUM TOXIN. Zbl. Bakt. Hyg., I. Abt. Orig. A 230: 59-66. 1975. In English with German summ. SFA 21(1).

This study has shown for the first time that fish such as eels (*Anguilla anguilla* L.) and carp (*Cyprinus carpio* L.) are sensitive to type E botulinum toxin. With oral administration the MLD for eels was 27,500 mouse LD(50) per kg bodyweight, while for carp it was only 236 mouse LD(50) per kg.

Carp were also found to be sensitive to a slight degree to type C botulinum toxin, the MLD of the most virulent toxin of this type being 457,000 mouse LD(50) per kg with oral administration.

Eels, however, showed no sensitivity to type C toxin.

76-000383 Hamelink, J. L.; Waybrant, R. C. (Eli Lilly & Co., Box 708, Greenfield, IN 46140) DDE AND LINDANE IN A LARGE-SCALE MODEL LENTIC ECOSYSTEM. Trans. Am. Fish. Soc. 105 (1): 124-134. Jan. 1976. SFA 21(1).

The fate of DDE and lindane added to the epilimnion of a thermally-stratified, flooded limestone quarry was followed for one year. DDE was distributed rapidly throughout the system, due to an influx of sediment generated by a rainstorm, while lindane persisted in the epilimnion until turnover. Concentration factors for zooplankton at equilibrium averaged 33 for lindane and 4.5×10^4 for DDE, while the same values for bluegill were 768 and 1.1×10^5 , respectively. Rainbow trout planted 134 days after treatment showed a concentration factor for DDE of 1.8×10^5 within 108 days, even though less than 1 part per trillion of DDE remained in the water. The distributions of DDE and lindane in the system were controlled chiefly by sediment-water interactions.

76-000384 Hodson, P. V. (Canada Cent. Inland Waters, Burlington, ON L7R 4A6, Canada) DELTA-AMINO LEVULINIC ACID DEHYDRATASE ACTIVITY OF FISH BLOOD AS AN INDICATOR OF A HARMFUL EXPOSURE TO LEAD. J. Fish. Res. Board Can. 33 (2): 268-271. Feb. 1976. In English with French summ. SFA 21(1).

The activity of red cell delta-amino levulinic acid dehydratase of rainbow trout (*Salmo gairdneri*) was depressed after exposure of the fish to lead. Concentrations of lead in water as low as 13 ug/liter caused a significant inhibition of activity after only 4-wk exposure. Assays of this enzyme's activity may provide a short-term indication of long-term harmful effects of lead.

76-000385 Iwama, G. K.; Greer, G. L.; Larkin, P. A. (Dep. Zool., Univ. British Columbia, Vancouver, BC V6T 1W5, Canada) CHANGES IN SOME HEMATOLOGICAL CHARACTERISTICS OF COHO SALMON (*ONCORHYNCHUS KISUTCH*/) IN RESPONSE TO ACUTE EXPOSURE TO DEHYDROABIETIC ACID (DHAA) AT DIFFERENT EXERCISE LEVELS. J. Fish. Res. Board Can. 33 (2): 285-289. Feb. 1976. In English with French summ. SFA 21(1).

To determine if changes in some hematological parameters accompanied acute exposure of juvenile coho salmon (*Oncorhynchus kisutch*) to dehydroabiatic acid (DHAA) at three different exercise levels, clotting times, hematocrits, erythrocyte sedimentation rates, red blood cell counts, and white blood cell counts were monitored over 6-, 12-, 24-, and 48-h exposure periods to 0.75 mg/liter DHAA.

White cell counts decreased significantly after 24-h exposure and there was a significant increase in clotting times after 48 h exposure to DHAA. In both cases, differences between experimentals and controls were significant only at low and intermediate exercise levels and not at a high exercise level. Hematocrits, erythrocyte sedimentation rates, and red blood cell counts were not significantly different between experimentals and controls for any of the exposure periods or exercise levels.

76-000386 Menasveta, P. EFFECTS OF CERTAIN FOOD ADDITIVES ON MERCURY ACCUMULATION, DISTRIBUTION, AND ELIMINATION IN SALMONID FISHES, AND THE RESULTS ON GROWTH. Ph.D. dissertation, Univ. Wash. 159p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(7), 1975. SFA 21(1).

With the use of scrap fish as a source of fish meal in fish diets, and the reported findings of significant mercury content in scrap fish, it was deemed necessary to determine the dynamics of possible mercury accumulation in fish fed such diets and to investigate possible methods to decrease absorption of mercury into their tissues.

The first experiment was undertaken to determine the effects on growth and behavior and the accumulation, elimination, and distribution of mercury in various organs in the entire fish when orange peel (the epicarp of naval oranges) and trisodium salt of nitrilotriacetic acid (NTA) were administered to rainbow trout fingerlings (*Salmo gairdneri*) simultaneously with mercury compounds. After a feeding period of 10 weeks, the growth response was the highest in the most heavily mercury-contaminated fish, whereas the least heavily-contaminated fish exhibited the lowest growth response. Methylmercury accumulation in fish was very much higher than mercury as mercuric chloride. Orange peel and NTA reduced the methylmercury accumulation in the fish approximately 50 percent and 30 percent, respectively, when compared with fish fed methylmercury without either additive. Orange peel and NTA also significantly reduced inorganic mercury accumulation. Rainbow trout required approximately 28 weeks to eliminate half the amount of methylmercury existing in their bodies. The main route of mercury elimination was via the kidneys. In fish administered mercuric chloride, the highest percentage of mercury in

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the total fish was found in the miscellaneous parts (the composite of head, bone, skin, and visceral mass). On the contrary, in the fish administered methylmercuric chloride the highest percentage of mercury in the total fish was found in the muscle.

The second experiment was undertaken to determine the effects of eight kinds of fish diets on the growth and mercury uptake of chinook salmon fry (*Oncorhynchus tshawytscha*). The diets contained fish meal produced from a number of kinds of marine fish that contained different levels of naturally-occurring mercury. Seven of the diets produced comparable growth rates, and only the fish fed the commercial meal diet grew at a significantly slower rate. Orange peel fed at 2.5 and 5.0 percent in the salmon meal diet did not significantly retard fish growth, whereas orange peel at 10 percent in the salmon diet did retard fish growth. The mercury concentration was significantly higher in the marine waste diet than in the other seven diets fed to the fish. The marine waste diet caused the highest mercury uptake in the fish, followed by the commercial fish meal diet. The other six diets resulted in similar levels of mercury uptake. (From Auth. Abstr.)

76-000387 Morrow, J. E.; Gritz, R. L.; Kirton, M. P. (Dep. Biol. Sci., Univ. Alaska, Fairbanks 99701) EFFECTS OF SOME COMPONENTS OF CRUDE OIL ON YOUNG COHO SALMON. Copeia 1975 (2): 326-331. 23 May 1975. SFA 21(1).

Among oil components tested for toxicity to young coho salmon, aliphatic compounds produced no significant mortalities. Mono-cyclic aromatics were generally toxic, the degree of toxicity increasing with the degree of unsaturation. It is suggested that the toxicity of these substances is brought about through alteration of cell membrane permeability, especially in the gills. This results in a rapid increase in the concentration of monovalent ions in the blood and probably also interferes with $\text{CO}(2)\text{-HCO}(3)\text{-}$ regulation.

76-000388 Norstrom, R. J.; McKinnon, A. E.; deFreitas, A. S. W. (Canadian Wildl. Serv., Toxic Chem. Div., Ottawa, ON K1A 0H6, Canada) A BIOENERGETICS-BASED MODEL FOR POLLUTANT ACCUMULATION BY FISH. SIMULATION OF PCB AND METHYLMERCURY RESIDUE LEVELS IN OTTAWA RIVER YELLOW PERCH (*PERCA FLAVESCENS*). J. Fish. Res. Board Can. 33 (2): 248-267. Feb. 1976. In English with French summ. SFA 21(1).

A pollutant accumulation model is developed which successfully predicts concentrations of PCBs and methylmercury in tissues of yellow perch (*Perca flavescens*) from the Ottawa River, Canada. The model is based on pollutant biokinetics coupled to fish energetics. The expression for metabolic rate includes a growth dependent term for estimating the contribution to metabolism of seasonal and annual growth in each age-class. Uptake of pollutant from food is based on caloric requirements for respiration and growth coupled to concentration of pollutant in food and its assimilation efficiency from the diet. Uptake of pollutant from water is based on flow of water past the gills for respiration coupled with concentrations of pollutant in water and the efficiency of its assimilation by gills. Pollutant clearance is related to body weight raised to the power of .58, but is independent of metabolic rate. Under steady state conditions of chronic exposure, the predicted ratio of uptake to clearance is roughly constant at all weights, and the slope of a curve of log pollutant concentration in tissues vs. log body weight can be used to establish the exponent of body weight for clearance.

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76-000389 O'Kelley, J. C.; Deason, T. B. (Dep. Biol., Univ. Ala., Tuscaloosa 35486) DEGRADATION OF PESTICIDES BY ALGAE. U. S. Environ. Prot. Agency Ecol. Res. Ser. EPA-600/3-76-022. vi + 42p. Mar. 1976. SFA 21(1).

In this investigation interactions of 12 pesticides with 37 strains of fresh water algae were studied in an effort to determine something of the variability in responses of fresh water algae to the variety of pesticides in use or projected to be used in the future.

Three interactions were investigated. One was the toxicity of the pesticides to these algae. Another was the sorption of several of the pesticides by some of the species of algae. The third was the possibility that some of the pesticides can be degraded by action of algae.

In general it was found that sensitivity of algae to pesticides varied greatly with the strains tested.

Sorption of methoxychlor appeared to be mainly physical, since much of the methoxychlor sorbed was exchangeable. The butoxyethyl ester of 2,4-D (2,4-DBE) was not sorbed to a significant extent by two green algae tested, and the sorption of carbaryl was very slow.

Malathion can be degraded by algae in the presence of light. One breakdown product, malathion monoacid (beta form), appeared as the malathion was being degraded, and later disappeared. Investigations of the fate of 2,4-DEE and methoxychlor in algal cultures suggest that these pesticides may also be degraded by algal activity.

76-000390 Reinhold, K. A. EFFECTS OF THE SYNERGIST PIPERONYL BUTOXIDE ON TOXICITY AND METABOLISM OF PESTICIDES IN GREEN SUNFISH (/LEPOMIS CYANELLUS/ RAFINESQUE). Ph.D. dissertation, Univ. Ill. 85p. 1974. From Diss. Abstr. Int. B Sci. Eng. 35(11), 1975. SFA 21(1)

The toxicities of methoxychlor and trifluralin were synergized by PB, but PB antagonized the toxicity of phorate, presumably by interfering with microsomal oxidation of the insecticide to the P=O analog and to sulfoxides and sulfones. The toxicity of aldrin was not affected by PB, as might be expected since dieldrin, the major metabolite, is nearly as toxic as aldrin. At the level used, carbofuran was not toxic either with or without PB. Under winter temperatures and light conditions, methoxychlor was more toxic but trifluralin and aldrin were less toxic than under summer conditions.

Residues of the pesticides in water persisted considerably longer in winter than in summer as a result of several factors, including less light exposure, lower temperature and a resulting slower rate of biodegradation, and fewer organisms for biodegradation. In the fish, PB decreased the relative proportions of residues occurring as dieldrin compared to aldrin. The synergist decreased the rate of epoxidation of aldrin to dieldrin.

The effects of PB on metabolism of C¹⁴-labeled aldrin, methoxychlor, and trifluralin were investigated. (From Auth. Abstr.)

76-000391 Robertson, T.; Waugh, G. D.; Mol, J. C. M. (Minist. Agric. Fish., Wellington, New Zealand) MERCURY LEVELS IN NEW ZEALAND SNAPPER /CHRYSOPTERYGON AURATUS/. N. Z. J. Mar. Freshwater Res. 9 (3): 265-272. Sept. 1975. SFA 21(1).

The New Zealand snapper /Chrysophrys auratus/ is the object of a major fishery and contributes approximately 30 percent of the annual landed weight of fin fish. Samples of 65 fish from 7 localities on the New Zealand coast were analysed for mercury. Though there is an increase in mercury concentration with size of fish, the larger, older individuals with relatively high mercury levels contribute only a small proportion to the landed catch. Therefore, in establishing the average concentration of mercury in fish, due weight should be

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accorded to the differences in size composition of the catch. On this basis the average levels of mercury in snapper offered for human consumption are of the order of 0.25 ppm. As this is only half the "permissible safe level" of most other countries where fish consumption is much higher, the risk to the New Zealand consumer is negligible.

76-000392 Robinette, H. R. (Dep. Wildl. Fish., Miss. State Univ., Mississippi State 39762) EFFECT OF SELECTED SUBLETHAL LEVELS OF AMMONIA ON THE GROWTH OF CHANNEL CATFISH (/ICTALURUS PUNCTATUS/). Prog. Fish-Cult. 38 (1): 26-29. Jan. 1976. SFA 21(1).

Four growth experiments were conducted with fingerling channel catfish (/Ictalurus punctatus/) in a series of fiber glass tanks containing water with un-ionized ammonia nitrogen concentrations of 0.01, 0.06, 0.12, and 0.13 ppm. There was a significant reduction of growth of the experimental fish at 0.12 and 0.13 ppm NH₃-N (/t-test/, /P/ less than 0.05). Although hyperplasia of the lamellae of the gills was seen in all fish examined, it was most extensive in fish from water with the highest sublethal concentration of un-ionized ammonia nitrogen.

An un-ionized ammonia nitrogen concentration of 2.36 ppm was established as the 24-h TL₅₀ value for channel catfish fingerlings in water with a methyl orange alkalinity range of 400-500 ppm, pH range of 8.5-8.9, and no free carbon dioxide. Previous work has shown that a lower pH and the presence of carbon dioxide might result in a lower value.

The results of these experiments demonstrate that sublethal levels of un-ionized ammonia can lead to a reduction in growth of channel catfish fingerlings. Inasmuch as levels of ammonia sufficient to reduce growth might be encountered in high-density fish culture, un-ionized ammonia should be monitored.

76-000393 Warlen, S. M. ACCUMULATION AND RETENTION OF DDT BY ATLANTIC MENHADEN, /BREVOORTIA TYRANNUS/. Ph.D. dissertation, N.C. State Univ. (Raleigh) 116p. 1974. From Diss. Abstr. Int. B Sci. Eng. 36(7), 1976. SFA 21(1).

DDT (and its metabolites DDD and DDE) and dieldrin were measured in young-of-the-year menhaden sampled during their residency in Newport River estuary in North Carolina. Water, bottom sediment, and seston were concurrently sampled to determine the source of residues to menhaden. Detectable concentrations of DDT and dieldrin were not found in centrifuged water and only trace amounts of DDT were present in the sediments. DDT and dieldrin were detected consistently in all life stages of menhaden and in their food, the seston. It is inferred that the diet is the principal source of DDT and dieldrin residues to menhaden in the Newport River estuary. (From Auth. Abstr.)

76-000394 Weis, J. S.; Weis, P. (Dep. Zool. Physiol., Rutgers Univ., Newark, NJ 07102) OPTICAL MALFORMATIONS INDUCED BY INSECTICIDES IN EMBRYOS OF THE ATLANTIC SILVERSIDE, /MENIDIA MENIDIA/. NOAA Fish. Bull. 74 (1): 208-211. Jan. 1976. SFA 21(1).

76-000395 Winner, R.; Caris, N.; Van Dyke, S. (Dep. Zool., Miami Univ., Oxford, OH 45056) AN EVALUATION OF THE RESPONSE OF MACROINVERTEBRATE RIFFLE COMMUNITIES TO A CHRONIC COFFER STRESS IN AN EXPERIMENTALLY POLLUTED STREAM. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

A gradient was created by introducing a point-source of copper into a stream at a concentration of 120 ug/l. Macroinvertebrates were collected from six riffle stations over a three month interval. Mean copper concentrations for these six stations were: 9, 121, 66, 46, 33, and 21 ug/l. The following indices were used to evaluate the response of community structure to the copper stress: (1) Shannon's diversity index based on both numbers and biomass; (2) total individuals per sample; (3) number of species per sample; and (4) biomass per sample. Of the four indices, total individuals per sample was most strongly and significantly correlated with copper concentration ($r = -0.62$, $F = 0.0001$). The degree of correlation between copper concentration and both biomass and number of species was somewhat less ($r = -0.48$ and $P = 0.01$ in both cases). Shannon's index was poorly correlated with copper concentration; based on biomass, r was -0.11 ($P = 0.57$) and based on numbers, r was $+0.07$ ($P = 0.70$). Analysis of variance and Duncan's new multiple range stress were used to evaluate the sensitivity of each index in relation to the copper stress. Indices ranked in order of decreasing sensitivity were: number of individuals: number of species: biomass: Shannon's index based on either numbers or biomass.

FISH TOXICANTS

76-000396 Beard, T. D. (Wis. Dep. Nat. Resour., Spooner) IMPACT OF REPEATED ANTIMYCIN TREATMENTS ON THE ZOOPLANKTON AND BENTHIC ORGANISMS IN CAMP, LAMEREAU AND NANCY LAKES, BAYFIELD COUNTY, WISCONSIN. Wis. Dep. Nat. Resour. Res. Rep. 78. 10p. Dec. 1974. SFA 21(1).

1. Because of natural fluctuations in zooplankton numbers during the summer the timing in collecting samples for an assessment of the effect of a certain chemical on the zooplankton is critical. Adequate assessments of a treatment can be made if samples are taken once a week one month prior and once a week for a month following treatment as well as the day of the treatment and the day after treatment.

2. Factors such as the effects of temperature on zooplankton abundance, intraspecific and interspecific competition and effects of introducing a fish population in lakes which had no population probably had a greater effect on zooplankton abundance than the antimycin treatment. All the zooplankton found in the lakes before the chemical treatments were found after the treatment except for *Leptodora kindti*. This particular zooplankton was collected in one sample in both Camp and LamerEAU Lakes and could have been present after the treatments but not collected.

None of the abundant benthic organisms were eliminated from the lakes after treatment with 3 ppb antimycin. The changes in abundance that occurred in the lakes after treatment were probably due to emergence, immigration, emigration and variation in abundance of organisms among sample sites, rather than from the treatment. (Auth. Summ.)

76-000397 Dawson, V. K.; Marking, L. L.; Bills, T. E. (Fish Control Lab., P.O. Box 862, La Crosse, WI 54601) REMOVAL OF TOXIC CHEMICALS FROM WATER WITH ACTIVATED CARBON. Trans. Am. Fish. Soc. 105 (1): 119-123. Jan. 1976. SFA 21(1).

Activated carbon was effective in removing fish toxicants and anesthetics from water solutions. Its capacity to adsorb 3-trifluoromethyl-4-nitrophenol (TFM), antimycin, Noxfish (5 percent rotenone), Dibrom, juglone, MS-222, and benzocaine ranged from 0.1 to 64 mg per gram of carbon. The adsorptive capacity (end point considered as a significant discharge) of activated carbon for removal of TFM was determined at column depths of 15, 30, and 60 cm; temperatures of 7, 12, 17, and 22 C; pH's of 6.5, 7.5, 8.5, and 9.5; and flow rates of 50, 78, 100, 200, and 940 ml/min. Adsorptive capacity increased when the contact time was increased by reducing the flow rate or increasing the column depth. The absorptive capacity was not significantly influenced by temperature but was substantially higher at pH 6.5 than at the other pH's tested. A practical and efficient filter for purifying chemically treated water was developed.

76-000398 Hunn, J. B.; Allen, J. L. (U.S. FWS, Fish Contr. Lab., La Crosse, WI 54601) RESIDUE DYNAMICS OF QUINALDINE AND TFM IN RAINBOW TROUT. Gen. Pharmac. 6: 15-18. 1975. SFA 21(1).

Study of the residue dynamics of 2-methylquinoline (quinaldine) and 3-trifluoromethyl-4-nitrophenol (TFM) in rainbow trout yielded the following findings:

1. Uptake and distribution of TFM by trout was influenced by the biotransformation of the lipid-soluble free phenol. No such effect was observed with quinaldine.

2. Disappearance of quinaldine and TFM from gallbladder bile was slower than from plasma or muscle during 24 hr of withdrawal in fresh water.

3. The concentration of TFM conjugate may exceed that of free TFM in bile by a factor of 10.

76-000399 Mayer, F. L., Jr.; Mehrle, P. M., Jr.; Dwyer, W. P. (U.S. FWS, Fish-Festicide Res. Lab., Columbia, MO 65201) TOXAPHENE EFFECTS ON REPRODUCTION, GROWTH, AND MORTALITY OF BROOK TROUT. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-600/3-75-013. viii + 42p. Nov. 1975. SFA 21(1).

Yearling brook trout (*Salvelinus fontinalis*) were continuously exposed to toxaphene (0, 39, 68, 139, 288, and 502 ng/l) in a flow-through diluter system. Day length and water temperature were altered monthly to correspond to natural conditions. Adult growth was reduced in the 288 and 502 ng/l toxaphene exposures, and the added stress of spawning activities caused extensive mortalities in these concentrations. The numbers of eggs spawned and percent viability were inversely related to increasing toxaphene concentrations. All groups of fry exposed to toxaphene had reduced rates of growth and survival. Biochemical investigations on fry backbones demonstrated that bone collagen may be a sensitive indicator of normal and abnormal growth and development prior to being observed in the whole fish. Toxaphene was accumulated by brook trout 5,000 to 76,000 times that in the water and the more chlorinated isomers of toxaphene were preferentially stored.

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76-000400 Meyer, F. P.; Schnick, R. A.; Cumming, K. B. (U.S.FWS, Fish Control Lab., La Crosse, WI 54601) REGISTRATION STATUS OF FISHERY CHEMICALS, FEBRUARY 1976. Prog. Fish-Cult. 38 (1): 3-7. Jan. 1976. SFA 21(1).

Changes in the regulation of pesticide and drug use initiated in 1972, after enactment of the Federal Environment Pesticide Control Act, required the updating of inadequate registrations and clearance of compounds not registered for fishery use. In 1972, only Terramycin and sulfamerazine had adequate registrations, although 11 other compounds had limited registrations for fishery use. A cooperative Federal and industry research effort was undertaken to obtain approval for fishery uses. As a result, 18 compounds had acquired fishery registrations by February 1976--nine for food and nine for nonfood uses. Chemicals with food use registrations are copper sulfate, 2,4-D, Diquat, endothall, lime, salt, simazine, sulfamerazine, and Terramycin; compounds with nonfood use registrations are antimycin, Bayluscide, 3-trifluoromethyl-4-nitrophenol (TFM), the combination of TFM and Bayluscide, Mascten, MS-222, rotenone, Casoron, and Furanace. Seven chemicals recently submitted to regulatory agencies for initial or further rulings on uses are TFM, formalin, Thanite, quinaldine sulfate, quinaldine sulfate:MS-222, malachite green, and calcium hypochlorite.

76-000401 Thruston, A. D., Jr. (U.S. EPA, Environ. Res. Lab., Athens, GA 30601) A QUANTITATIVE METHOD FOR TOXAPHENE BY GC-CI-MS SPECIFIC ION MONITORING. U.S. Environ. Prot. Agency Environ. Monit. Ser. EPA-600/4-76-010. vi + 22p. Mar. 1976. SFA 21(1).

A method was developed for the identification and quantification of toxaphene using a Specific Ion Monitoring (SIM) program with GC-CI-MS. Interferences from DDT's and Arochlor 1260 are eliminated or minimized. GC-CI-MS was also used to distinguish toxaphene from strobane.

RESEARCH AND MANAGEMENT-GENERAL

76-000402 Anderson, R. O. (Coop. Fish. Unit, Stephens Hall, Univ. Mo., Columbia 65201) OPTIMUM SUSTAINABLE YIELD IN INLAND RECREATIONAL FISHERIES MANAGEMENT. In P. M. Roedel, ed. Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish. Soc. Spec. Publ. No. 9: 29-38. Sept. 1974[1975]. SFA 21(1).

76-000403 Burstall, P. J. (Dep. Internal Affairs, Wildl. Div., Wellington, New Zealand) SPORT FISHERIES. In V. H. Jolly and J. M. A. Brown, eds. New Zealand Lakes. Auckland Univ. Press/Oxford Univ. Press. 308-350. 1975. SFA 21(1).

76-000404 Carlton, F. E. (Natl. Coalition Mar. Conserv., Inc., P.O. Box 3458, Savannah, GA 31403) OPTIMUM SUSTAINABLE YIELD AS A MANAGEMENT CONCEPT IN RECREATIONAL FISHERIES. In F. M. Roedel, ed. Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish. Soc. Spec. Publ. No. 9: 45-49. Sept. 1974[1975]. SFA 21(1).

SPORT FISHERY ABSTRACTS

76-000405 Crutchfield, J. A. (Dep. Econ., Univ. Wash., Seattle 98195) AN ECONOMIC VIEW OF OPTIMUM SUSTAINABLE YIELD. In P. M. Roedel, ed. Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish. Soc. Spec. Publ. No. 9: 13-19. Sept. 1974[1975]. SFA 21(1).

76-000406 Foyle Fisheries Commission (8 Victoria Rd., Londonderry, Northern Ireland) TWENTY-THIRD ANNUAL REPORT 1974. Foyle Fish. Comm. viii + 108p. Mar. 1975. SFA 21(1).

76-000407 Harville, J. P. (Pacific Mar. Fish. Comm., 342 State Office Bldg., 400 S.W. Fifth Ave., Portland, OR 97201) MULTIDISCIPLINARY ASPECTS OF OPTIMUM SUSTAINABLE YIELD. In P. M. Roedel, ed. Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish. Soc. Spec. Publ. No. 9: 51-64. Sept. 1974[1975]. SFA 21(1).

76-000408 Kerr, S. R. (Ontario Minist. Nat. Resour., Fish Wildl. Br., Maple, ON L0J 1E0, Canada) ECOLOGICAL ANALYSIS AND THE FRY PARADIGM. J. Fish. Res. Board Can. 33 (2): 329-332. Feb. 1976. In English with French summ. SFA 21(1).

Appreciation of the essential distinction between internal and external methods of analysis is a fundamental component of the Fry paradigm. Investigation of the emergent behaviors of systems, observed at several hierarchical levels of ecological organization, is emphasized in his work. Internal analysis is always preceded by observation of the relevant external variables. The value of this approach is clear when assessed in terms of recent developments in systems theory.

76-000409 Loftus, K. H. (Minist. Nat. Resour., Sport Fish. Branch, Toronto, ON, Canada) A NEW APPROACH TO FISHERIES MANAGEMENT AND F.E.J. FRY'S ROLE IN ITS DEVELOPMENT. J. Fish. Res. Board Can. 33 (2): 321-325. Feb. 1976. In English with French summ. SFA 21(1).

Fisheries management has undergone a complex and tortuous process of development. From its initial stages as a largely intuitive activity, gradual incorporation of a biological basis has greatly strengthened its effectiveness. At present, there is considerable promise that a coherent, scientifically sound body of management science will soon emerge. The influence of F.E.J. Fry is inextricably associated with these developments.

76-000410 Mauermann, R. G. (Texas Shrimp Assoc., P.O. Box 1666, 305 First Natl. Bank Bldg., Brownsville 78520) OPTIMUM SUSTAINABLE YIELD-COMMERCIAL FISHERIES VIEWS. In P. M. Roedel, ed. Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish. Soc. Spec. Publ. No. 9: 39-43. Sept. 1974[1975]. SFA 21(1).

76-000411 Roedel, P. M., ed. (NMFS, Rockville, MD 20852) OPTIMUM SUSTAINABLE YIELD AS A CONCEPT IN FISHERIES MANAGEMENT. Am Fish Soc. Spec. Publ. No. 9. vii + 89p. Sept. 1974[1975]. SFA 21(1).

Proceedings of a symposium held during the 104th annual meeting of the American Fisheries Society, Honolulu, Hawaii, Sept. 9, 1974.

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ADMINISTRATION AND PLANNING

76-000412 Ogballai, R.; Mullen, M. (Wis. Dep. Nat. Resour., Madison 53701) WISCONSIN'S PARTICIPATION IN THE RIVER BASIN COMMISSIONS. Wis. Dep. Nat. Resour. Tech. Bull. No. 91. 12p. 1975. SFA 21(1).

The Federal Water Resources Planning Act of 1965 established a Federal Water Resources Council to oversee the national interest in water resources, provided for the formation of regional river basin commissions, and funded the states to develop comprehensive water and related land resources plans.

Wisconsin receives grants for water resource planning and participates in both the Great Lakes Basin Commission and the Upper Mississippi River Basin Commission. The state, through the Department of Natural Resources representatives, has contributed to commission studies and plans.

Wisconsin is benefitting from the Commissions' recently completed basinwide framework studies and will benefit even more from the intensive studies of state river basins. The report makes recommendations to the Water Resources Council and river basin commissions for improving the effectiveness of this means of water resources planning. Suggestions focus on public participation, funding, and management studies.

HABITAT ALTERATION

76-000413 Adkins, G.; Bowman, P. (La. Wildl. Fish. Comm., 400 Royal St., New Orleans 70130) A STUDY OF THE FAUNA IN DREDGED CANALS OF COASTAL LOUISIANA. La. Wildl. Fish. Comm. Tech. Bull. No. 18. ix + 72p. Feb. 1976. SFA 21(1).

Since the mid-1700s, coastal Louisiana has been subjected to digging, ditch cutting, canal construction, and channelization operations. During the past 200 years, in excess of 4,573 miles of canals and channels have been created in Louisiana's coastal marshlands. These activities were largely unregulated and unmonitored by any agency other than those which were involved in petroleum exploitation, navigation, and flood control.

In attempts to investigate biological and hydrological parameters now associated with these artificial wetland features, samples were made in four environment types: (a) open, unaltered areas, (b) open canals, (c) semi-open canals, and (d) closed canals. Sampling was accomplished by using various gear over a two-year period.

During the study, 67,560 individuals composed of 88 different species were collected with a 16-foot otter trawl. Open, undisturbed areas offered the largest numbers of individuals and closed canals contained the fewest, although animals taken in closed canals were larger in size.

Catches of planktonic organisms in open and semi-open canals were similar. A decrease in catch and in species diversity was noted in closed canals.

Salinity ranged from a high of 30.0 parts per thousand to a low of 0.1 part per thousand, while a maximum temperature of 33.9 Centigrade and a minimum of 3.6 centigrade were recorded. Hydrological conditions were much more stable in closed canals than in any of the other three environmental types sampled. Dissolved oxygen remained within tolerance limits of marine organisms during most of the study; however, fish kills were observed in semi-open and closed canals.

Water chemistry reflected a trend of fluctuation dependent upon fresh water and saltwater intrusion. Peak levels of most nutrients

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were recorded following freshwater flooding conditions or storm surges caused by the passage of hurricanes.

76-000414 Avery, E. L. (Wis. Dep. Nat. Resour., Waupaca)
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT AT WESTFIELD CREEK. Wis. Dep. Nat. Resour. Res. Rep. 76. 23p. Dec. 1974. SFA 21(1).

(1) Westfield Creek is marginal trout water where annual stocking is necessary to sustain the fishery, where access to the stream and permission to fish is at the discretion of private landowners, and where chemical treatment is again necessary to remove abundant populations of nontrout fishes. Repeated chemical treatment every 5-7 years and subsequent stocking with trout is not recommended, however, unless fishing easements and access routes can be obtained by the INR along the upper half of the 3.6-mile segment of stream.

(2) If the above prerequisites are accomplished, trout should be stocked only in the upper 1.75 miles of Westfield Creek where water temperatures are cooler and instream cover most abundant. (The majority of trout from previous stocks preferred to reside here and most of the fishing pressure was exerted in this portion of stream).

(3) Due to the poor "taste" acquired by trout in Westfield Creek, greater emphasis should be given to establishing a "trophy" fishery for trout in the 15-20 inch size range.

(4) Considering the better survival, longer life span, attainment of larger size and better overall growth of brown trout in Westfield Creek, only brown trout should be stocked.

(5) Brown trout should be stocked as fingerlings (age 0) either in the fall or early spring. Five times as many fingerlings stocked in the fall should be stocked in the spring to provide comparable numbers of trout available to the angler in subsequent fishing seasons. Number of fall fingerlings recommended is 3,000.

(6) A solution to the large, almost daily fluctuations in discharge of Westfield Creek should be sought. Better survival and perhaps a significant amount of natural reproduction could be achieved if a more constant discharge were maintained. (From Auth. Mgmt. Recomm. for Westfield Creek)

76-000415 Gelroth, J. V.; Marzolf, G. R. (Div. Biol., Kans. State Univ., Manhattan 66506) COMPARISONS OF PRIMARY PRODUCTION AND LEAF LITTER DECOMPOSITION IN NATURAL AND CHANNELIZED PORTIONS OF A KANSAS STREAM. Presented at the 24th Anna. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

Second-order streams that are associated with a riparian forest are generally characterized as heterotrophic systems, dependent upon allochthonous sources of organic matter. When these streams are channelized, decreasing allochthonous organic matter input and reducing shading, with consequent increased solar energy input, they would be expected to shift to an autotrophic condition.

Processes such as primary production and leaf litter degradation would be expected to be affected since channelization alters both the physical and the biological nature of a stream. The objectives of this study were to test hypotheses about the nature of these processes in natural and channelized portions of a second-order stream of the Kansas Flint Hills. Diurnal oxygen curve analysis and leaf pack degradation analysis provided the experimental tests. The channelized portion of the stream had higher photosynthetic rates, lower leaf degradation rates, greater daily mean water temperatures and higher oxygen concentration values than the more natural portion of the stream. Photosynthesis/respiration ratios were less than one in the natural portion of the stream and greater than one in the channelized portion, indicating the shift from heterotrophic to autotrophic

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conditions.

76-000416 Gore, J. A. (Dep. Zool., Univ. Mont., Missoula 59801)
EFFECTS OF A TEMPORARY MASSIVE FLOW REDUCTION ON THE BENTHIC
INVERTEBRATES OF A PRAIRIE RIVER. Presented at the 24th Annu.
Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976.
Mar. 1976. SFA 21(1).

On October 30, 1971, the Tongue River Reservoir Dam, in eastern Montana, was shut down for repairs for a period of six weeks. Flow was reduced from an average discharge of 190 c.f.s. to 25 c.f.s. in the upper regions to 90 c.f.s. in the lower reaches. A kite diagram of invertebrate distribution before dam closure is shown. Of particular interest is the dominance of the molluscs, /Physa/ and /Sphaerium/, in the length of the river thermally influenced by the hypolimnion drain of the dam. Diversity increases in the remaining part of the river where insect species are dominant. At the time of dam closure a 96-hour drift sample was taken with collections being made every four hours. Since the drop in the flow was extremely gradual, taking two weeks to reach minimum flow, drift patterns continued as before closure but were elevated in numbers of organisms per sample. A longitudinal sample after closure and when low flow had been attained shows the absence of molluscs in the cold water reach and the dominance of the tubellarian, /Dugesia/, whose density increased ten-fold. In the lower reaches of the river densities of invertebrates increased three-fold or more and many species once restricted to short lengths of the river are now found over the entire length of the lower river.

76-000417 LaBounty, J. F. (ed.) (Bureau of Reclamation, P.O. Box 25007, Bldg. 27, Denver Federal Center, Denver, CO 80225) THIRD WORKSHOP ON ECOLOGY OF PUMPED-STORAGE RESEARCH AT TWIN LAKES, COLORADO AND OTHER LOCALITIES. Bur. Reclamation, Denver, Colo. iii + 107p. Feb. 1976. SFA 21(1).

Contains abstracts of 22 papers concerned with various pumped-storage projects. (RS)

76-000418 Leedy, D. L.; Franklin, T. M.; Hekimian, E. C. (Urban Wildl. Res. Cent. Inc., 12789 Folly Quarter Rd., Ellicott City, MD 21043) HIGHWAY-WILDLIFE RELATIONSHIPS VOL. 2. AN ANNOTATED BIBLIOGRAPHY. Fed. Highway Adm. Rep. No. FHWA-RD-76-5. x + 417p. Dec. 1975. SFA 21(1).

This Volume is Volume 2 of a two volume report.

Volume 1. A State-of-the-Art Report.

Volume 2. An Annotated Bibliography.

76-000419 Leedy, D. L. (Urban Wildl. Res. Cent. Inc., 12789 Folly Quarter Rd., Ellicott City, MD 21043) HIGHWAY-WILDLIFE RELATIONSHIPS VOL. 1. A STATE-OF-THE-ART REPORT. Fed. Highway Adm. Rep. No. FHWA-RD-76-4. x + 183p. Dec. 1975. SFA 21(1).

This study assesses, primarily through an extensive literature review, what is known about highway-wildlife relationships and suggests research and management approaches to protect and enhance fish, wildlife, and environmental quality. A cooperative effort to this end among natural resource and highway agency personnel is needed on a continuing basis from the initial planning stages for new highway construction through operation and maintenance. The 20 million or more acres in highway rights-of-way have been largely neglected as wildlife habitat. Opportunities exist for creating valuable fish and wildlife impoundments during construction, yet the minimal effort needed to

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locate and design such impoundments has generally not been made. The Nation's four million miles of streets and highway often create "edges" conducive to wildlife. Many millions of wild vertebrates are killed annually, but apparently most wildlife populations are not seriously affected by such losses. Highway construction through limited ranges of endangered species can be a serious problem, as can erosion, wetland drainage, stream alteration, structures which block the passage of anadromous fish, and pollutants resulting from highway maintenance and use. Better measures for mitigating habitat losses, predicting effects of highways on fish and wildlife, reducing animal-vehicle accidents, and enhancing highway environment for fish, wildlife, and people are sorely needed.

This Volume is Volume 1 of a two volume report.

Volume 1. A State-of-the-Art Report.

Volume 2. An Annotated Bibliography.

76-000420 Sanders, D. F.; Jacobi, G. Z. (Wis. Coop. Fish. Res. Unit., Univ. Wis., Stevens Point 54481) EFFECTS OF STREAM CHANNELIZATION ON AQUATIC MACROINVERTEBRATES, EUENA VISTA MARSH, PORTAGE COUNTY, WISCONSIN. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

Quantitative benthos, drift, and water chemistry samples were collected and water temperature and stream discharge measurements were taken at approximately 6-week intervals during the ice-free period from June, 1974, through May, 1975. Six 100-meter sections were studied, 2 in natural streams, 2 in old ditches last dredged in 1913 and 1922, and 2 in new ditches dredged in 1967 and 1968. Sinuosity indices (channel length/linear length) were 1.00, 1.02, and 1.15 in upstream sections and 1.00, 1.03, and 1.58 in downstream sections for new ditches, old ditches, and natural streams, respectively. Gradients on all study sections were less than 1 percent.

Most taxa were collected in natural streams and fewest in new ditches. More drifting taxa were collected in the upstream new ditch and in the downstream natural section, which had the highest percentages of the least stable substrate, sand. Mean benthic biomass was highest in the upstream natural section and the downstream new ditch, which had the highest percentages of the more productive substrates, vegetation and silt-detritus. Mean daily temperature fluctuation and conductivity were consistently higher in new ditch sections.

76-000421 Trent, L.; Pullen, E. J.; Proctor, R. (NMFS, Panama City Lab., Panama City, FL 32401) ABUNDANCE OF MACROCRUSTACEANS IN A NATURAL MARSH AND A MARSH ALTERED BY DREDGING, BULKHEADING, AND FILLING. NOAA Fish. Bull. 74 (1): 195-200. Jan. 1976. SFA 21(1).

Indices of abundance of macrocrustaceans during March-October 1969 in West Bay, Tex., were determined for day and night and statistically compared between 1) a natural marsh area, 2) upland and bayward canal areas of a housing development, and 3) an open bay area. Significance levels of 5 percent or 1 percent were used in the statistical comparisons. Catches of brown shrimp, *Penaeus aztecus*; white shrimp, *P. setiferus*; blue crab, *Callinectes sapidus*; and pink shrimp, *P. duorarum*, were significantly greater at night than during the day at one or more stations in the marsh. More grass shrimp, *Palaemonetes* sp., were caught at night than during the day, but the differences were not statistically significant. Individuals of each species appeared to migrate into the more shallow areas of the marsh at night. At night, brown shrimp and blue crabs were significantly more abundant in the marsh and bayward canal areas than in the upland canal and bay areas, white shrimp were significantly more abundant in the marsh area

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than in the other three areas, and pink shrimp were significantly more abundant in the marsh than in the upland and bayward canal areas. During the day, brown shrimp were significantly more abundant in the bayward canal area than in the upland canal and bay areas, while pink shrimp were significantly more abundant in the marsh area than in the upland canal area. The generally lower catches of each species in the open bay and upland canal areas when compared with the marsh and bayward canal areas were attributed to: 1) permanent loss of intertidal vegetation in the housing development; 2) low abundance of detrital material and benthic macroinvertebrates in the open bay and upland canal areas; and 3) eutrophic conditions in the upland canal area.

76-000422 Zimmer, D.; Bachmann, R. (Dep. Anim. Ecol., Iowa State Univ., Ames 50011) THE EFFECTS OF LONG-REACH CHANNELIZATION ON INVERTEBRATE DRIFT IN SOME IOWA STREAMS. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

Invertebrate drift data were collected from 11 stream segments in north central Iowa during the summer months of 1974 and 1975. Gradients of the study sites ranged from 0.017 to 0.218 percent; sinuosity index values were between 0.95 and 1.67. There was a significant ($P = .05$) positive correlation between channel sinuosity and invertebrate drift density. The impact of channelization on invertebrate drift density could be related to the straightness of altered channels.

HARVEST, CREEL CENSUS

76-000423 Paxton, K. O. (Ohio Div. Wildl., 500 E. Main Cross St., Findlay 45840) EFFECTS OF ICE FISHING ON YELLOW PERCH IN AN OHIO UPGROUND RESERVOIR. Ohio Fish Wildl. Rep. 5. 11p. July 1975. SFA 21(1).

Yellow perch (*Perca flavescens*) comprised 93 percent of the total ice fishing harvest in January 1974, as determined by winter creel census. This concentrated winter harvest accounted for approximately 50 percent of the total year's harvest of perch. Large adult perch were more vulnerable to angling than smaller, more abundant yearling perch. Other fish species were only a minimal portion of the catch. Two algebraic equations developed to expand the empirical creel data are presented.

REGULATIONS

76-000424 Parks, W. W. A PACIFIC SALMON FISHERIES MODEL FOR THE STUDY OF GEAR REGULATION: AN APPLICATION TO THE WASHINGTON TROLL FISHERY. Ph. D. dissertation, Univ. Wash. 172p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(6), 1975. SFA 21(1).

A large scale, comprehensive computer simulation model of the Pacific coast salmon fisheries was constructed. The model was most detailed for the Washington fisheries. Thirty-five major salmon stocks were modeled spawning in areas from the Columbia River to the Fraser River. Gill net, purse seine, sport and troll gears were represented in ten fishing locations from Oregon to southeastern Alaska.

Troll season was varied for constant size limit and effort. Short seasons resulted in increased catch and landed value to net fisheries

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and decreased returns to troll fisheries. Long seasons produced opposite results. Troll chinook size limit was varied for constant season and effort. Low size limits resulted in increased catch and landed value to the troll fisheries and decreased returns to the net fisheries. High size limits produced opposite results.

Troll effort was reduced for constant season and size limit. Troll effort reduction resulted in increased total system catch, landed value and efficiency indices catch/effort and landed value/effort.

Regulating season, size limit and effort level in the Washington troll fishery alone was considerably less efficient than regulating these characteristics in all system troll fisheries together.

Sensitivity analyses identified natural mortality as the parameter to which model output was most sensitive. The model was insensitive to hooking mortality and migration timing.

A zero-inch chinook size limit and a four-month season were identified as the most effective troll regulations simulated. Under these regulations, troll-caused hooking mortality decreased while catch and landed value increased for all fisheries. This result was insensitive to hooking and natural mortality. Present value calculations revealed that implementing these regulations would be worth \$24.27 million in increased landed value to the system. (From Auth. Abstr.)

FISH CONTROL AND REMOVAL

76-000425 Sprules, W. M. (Ottawa, ON K1H 7N9, Canada) INITIATION OF SEA LAMPREY (/PETROMYZON MARINUS/) CONTROL. J. Fish. Res. Board Can. 33 (2): 326-329. Feb. 1976. In English with French summ. SFA 21(1).

Sea lamprey (/Petromyzon marinus/) control became a major undertaking, relative to many other programs in aquatic biology. In several respects, the history of the program, outlined here, provides an informative prototype that might be usefully considered by aquatic biologists. F.E.J. Fry played an influential role in the development of the program.

MARKING AND TAGGING

76-000426 Brandt, T. M.; Schreck, C. B. (Dep. Fish. Wildl. Sci., VPI & SU, Blacksburg, VA 24061) CRAYFISH MARKING WITH FLUORESCENT PIGMENT. Am. Midl. Nat. 94 (2): 496-499. Oct. 1975. SFA 21(1).

Fluorescent granular pigment sprayed with 738 g/cm² (105 psi) for 5, 10 and 20 sec intervals was used to mark crayfish in a laboratory study. The pigment was retained by 100 percent of the unmolted crayfish 35 days after treatment and by 65 percent of the crayfish 56 days after treatment. Crayfish which were induced to molt after being sprayed generally lost the fluorescent pigment during the molt. Mortality (2 percent) due to the marking procedures was minimal.



SPORT FISHERY ABSTRACTS

76-000427 Hauser, W. J.; Legner, E. F. (Div. Biol. Control, Univ. Calif., Riverside 92502) SIMPLE, INEXPENSIVE TECHNIQUE FOR TAGGING FISH. *Prog. Fish-Cult.* 38 (1): 18-19. Jan. 1976. SFA 21(1).

Tilapia zillii were tagged for individual identification with numbered tags made from embossing tape. Others, marked for recognition at long distances, were tagged with squares of plastic flagging tape. Tags were fastened with monofilament fishing line tied with a square knot in the antero-dorsal musculature. Some tags remained intact for 3 mo.

76-000428 Randolph, K. N. (Dep. Zool., Univ. Okla., Norman 73069) TANGLE-RESISTANT MARKER FOR OBSERVING FISH AT A DISTANCE. *Prog. Fish-Cult.* 38 (1): 43-44. Jan. 1976. SFA 21(1).

Inexpensive tangle-resistant markers for observing fish in shallow ponds at a distance were constructed of plastic air-line tubing. The design of the marker provided easy identification of individuals and reduced adverse affects on activity and growth.

76-000429 Zirges, M. H. (Oreg. Dep. Fish Wildl., Mar. Hdqtrs., Newport 97365) INEXPENSIVE DEVICE TO HOLD CODED WIRE TAGS FOR DECODING. *Prog. Fish-Cult.* 38 (1): 57. Jan. 1976. SFA 21(1).

This note describes a simple and inexpensive device for magnetically holding coded wire tags for decoding under a microscope.

STOCKING AND INTRODUCTIONS

76-000430 Clark, J. H. MANAGEMENT EVALUATION OF STOCKED NORTHERN PIKE IN COLORADO'S SMALL PLAINS RESERVOIRS. Ph.D. dissertation, Colo. State Univ. 74p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(8), 1975. SFA 21(1).

Northern pike (*Esox lucius*) of two size groups were stocked into several small plains reservoirs in Colorado. Small northern pike approximately 50-mm total length were stocked at an approximate rate of 62/ha, whereas large northern pike averaging 377-mm total length were stocked at an approximate rate of 25/ha. Out of 18 introductions of 50-mm northern pike, 9 (50 percent) resulted in no observable northern pike populations, 7 (39 percent) resulted in northern pike populations of too low a density to interest fishermen, and 2 (11 percent) resulted in northern pike populations of a density which would attract fishermen. Survival of 50-mm stocked northern pike was dependent upon large numbers of small sized (young-of-the-year) forage fishes. In the two instances when 50-mm fingerlings established in sufficient numbers to interest fishermen, cost per surviving catchable sized northern pike averaged \$0.14. Out of 4 introductions of 377-mm northern pike, all (100 percent) resulted in northern pike populations of a density which would interest fishermen. Survival of stocked 377-mm northern pike averaged 35 percent and cost per surviving fish averaged \$4.62. Few statistical differences in average size and number of resident fish populations were found within a year after northern pike were introduced into study reservoirs; although, the general trend was an increase in average total length and a decrease in number of resident fishes following introduction of northern pike.

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76-000431 Courtenay, W. R., Jr.; Robins, C. R. (Dep. Biol. Sci., Fla. Atl. Univ., Boca Raton 33432) EXOTIC ORGANISMS: AN UNSOLVED, COMPLEX PROBLEM. Bioscience 25 (5): 306-313. May 1975. SFA 21(1).

76-000432 Magnuson, J. J. (Ecology Program, National Science Foundation, Washington, DC 20550) MANAGING WITH EXOTICS--A GAME OF CHANCE. Trans. Am. Fish. Soc. 105 (1): 1-9. Jan. 1976. SFA 21(1).

Lakes are like islands--isolated, small and relatively young. These similarities suggest that the theory developed for species dynamics of islands by MacArthur and Wilson (1963) may be relevant to lakes. If so, the expectations are that the number of species in a lake is the result of an equilibrium between rates of immigration of the new species and extinction of existing species. The number of species would be lower in small, isolated lakes with simple habitat than in large or complex lakes or those exposed to a source of new species. Instability in species structure would be higher in lakes with a continuous source of new species or "exotics." The influence of immigrations on species structure would be greater in smaller or more simple habitats than in larger or more complex habitats. Man's activities increase both immigration and extinction rates and induce even greater instability to species structure and thus add greater uncertainty or "chance" into the results of fish management plans. Attempts to retain more "natural" rates of species exchange among lakes may reduce instability and increase predictability in fish management.

76-000433 Moring, J. R. (Oreg. Dep. Fish Wildl., Oreg. State Univ., Corvallis 97331) CONTRIBUTIONS OF DELAYED-RELEASE, PEN-CULTURED CHINOOK SALMON TO THE SPORT FISHERY IN PUGET SOUND, WASHINGTON. Prog. Fish-Cult. 38 (1): 36-39. Jan. 1976. SFA 21(1).

Delayed releases of 24,527 juvenile chinook salmon (*Oncorhynchus tshawytscha*), marked with color-coded wire head tags, were made from floating pens at four locations in Puget Sound, Washington. Movements were followed by recoveries for 2 years following release (1972-1974). During this period, 378 tagged salmon were recovered--351 by sport fishermen, 25 in hatchery traps and weirs, and 2 by commercial fishermen. Two important results were apparent: most delayed-release chinook remained in Puget Sound and were available to anglers, and captures by anglers were primarily from the general area of release. Highest returns were from the Squaxin Island release (5.8 percent); 83.3 percent of these were taken in the general area of release, South Puget Sound.

FISHING GEAR AND TECHNIQUES

76-000434 Engel, S. (Dep. Nat. Sci., Univ. Mich., Dearborn 48128) MOVABLE PLATFORM FOR WORKING ROLLING GILL NETS IN LAKES. Prog. Fish-Cult. 38 (1): 23-25. Jan. 1976. SFA 21(1).

A barge was designed to use in working vertical, rolling gill nets for the study of the depth distributions of fish. The barge was constructed from slotted, angle aluminum and six steel drums, with a sanded wooden deck. It was equipped with handrails, a bar to guide the net mesh, and lights for night work. Net racks, near opposite ends of the barge, were used to lift gill nets suspended from rollers. The barge is large enough to accommodate four persons and to store eight or more gill nets on the deck. It can service numerous nets at one sampling station or can be moved by motor boat to sample at other stations. The advantages of using such a barge, rather than a

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conventional, 14-ft boat with net racks, are that wider nets can be used and that many more nets can be serviced, yet some of the maneuverability of a small boat is retained. The usefulness and durability of the barge has been demonstrated by about 400 h of gill netting over a three-year period.

76-000435 Gilligan, M. R. (Dep. Ecol. Evol. Biol., Univ. Ariz., Tucson 85721) SMALL MARINE ANIMAL COLLECTOR FOR USE BY DIVERS. Prog. Fish-Cult. 38 (1): 40-41. Jan. 1976. SFA 21(1).

A hand-held small marine animal collector (SMAC), recently tested during a 6-week period in the Gulf of California, was found to be both durable and highly efficient for collecting immobilized fishes from small interstices and from all types of substrates. The piston and valve design with attached collecting bag made it possible for divers to make maximum use of collecting time. This paper describes the construction, use, and advantages of this device compared with other collecting methods.

76-000436 Schreck, C. B.; Whaley, R. A.; Bass, M. L.; Maughan, O. E.; Solazzi, M. (Oreg. Coop. Fish. Res. Unit., Oreg. State Univ., Corvallis 97331) PHYSIOLOGICAL RESPONSES OF RAINECUT TROUT (*SALMO GAIIRDNERI*) TO ELECTROSHOCK. J. Fish. Res. Board Can. 33 (1): 76-84. Jan. 1976. In English with French summ. SFA 21(1).

Electroshocking elicited an immediate increase in plasma corticoid and lactate concentrations and thrombocyte:leucocyte ratio in rainbow trout (*Salmo gairdneri*). Plasma glucose concentrations increased significantly after 3 h. Plasma protein, calcium, magnesium, and androgen levels were not measurably affected. Plasma lactate returned to preshock levels within 3 h, but corticoid and glucose concentrations remained elevated for at least 6 h. The fish coughed violently or did not resume normal breathing rates for 60 s post shocking. Although breathing frequency did not increase, buccal pressure increased substantially and required at least 1 h to return to preshock levels. Cardiac activity was irregular after shocking, but no predictable alterations in rate were evident thereafter. The height of the T wave in ECGs increased markedly 1-3 min after shocking. The electrophoretic patterns of 13 isoenzymes from liver, white muscle, and plasma did not differ between fish captured by dipnet and those captured by electrofishing.

Responses exhibited by fish to shocking are most likely attributable to combined effects of trauma, factors associated with paying off of an oxygen debt, and attributes associated with the general adaptation syndrome of stress. A substantial period of time of more than 6 h is required for fish to return to "normal" preshock conditions.

76-000437 Twedt, T. M.; Bernard, D. R. (Utah Water Res. Lab., Utah State Univ., Logan 84322) AN ALL-WEATHER, TWO-WAY FISH TRAP FOR SMALL STREAMS. Calif. Fish Game 62 (1): 21-27. Jan. 1976. SFA 21(1).

The design and construction of an all-weather, two-way fish trap for small streams are discussed with a description of the study stream. Operation, operational problems, and past history of usage are detailed.

FISHWAYS, FISH PASSAGE THROUGH DAMS, ETC.

76-000438 Morgan, R. P. II; Ulanowicz, R. E.; Rasin, V. J., Jr.; Noe, L. A.; Gray, G. B. (Chesapeake Biol. Lab., Univ. Md., Solomons, 20688) EFFECTS OF SHEAR ON EGGS AND LARVAE OF STRIPED BASS, *MORONE SAXATILIS*, AND WHITE PERCH, *M. AMERICANA*. Trans. Am. Fish. Soc. 105 (1): 149-154. Jan. 1976. SFA 21(1).

Shear stress, generated by water movement, can kill fish eggs and larvae by causing rotation or deformation. Through the use of an experimental apparatus, a series of shear (as dynes/cm²)-mortality equations for fixed time exposures were generated for striped bass and white perch eggs and larvae. Exposure of striped bass eggs to a shear level of 350 dynes/cm² kills 36 percent of the eggs in 1 min; 69 percent in 2 min, and 88 percent in 4 min; exposure of larvae to 350 dynes/cm² kills 9.3 percent in 1 min, 30.0 percent in 2 min, and 68.1 percent in 4 min. A shear level of 350 dynes/cm² kills 38 percent of the white perch eggs in 1 min, 41 percent in 2 min, 89 percent in 5 min, 96 percent in 10 min, and 98 percent in 20 min. A shear level of 350 dynes/cm² applied to white perch larvae destroys 38 percent of the larvae in 1 min, 52 percent in 2 min, 75 percent in 4 min. Results are experimentally used in conjunction with the determination of shear levels in the Chesapeake and Delaware Canal and ship movement for the estimation of fish egg and larval mortalities in the field.

76-000439 Scherer, M. D. ANALYSIS OF FACTORS AFFECTING PASSAGE OF AMERICAN SHAD (*ALOSA SAPIDISSIMA*, WILSON) AT HOLYOKE DAM, MASSACHUSETTS AND ASSESSMENT OF JUVENILE GROWTH AND DISTRIBUTION ABOVE THE DAM. Ph.D. dissertation, Univ. Mass. 262p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(2), 1975. SFA 21(1).

Holyoke Dam, located 139.4 km above the mouth of the Connecticut River, is presently the site of the most effective American shad (*Alosa sapidissima*) passage facility on the east coast. Stepwise multiple regression computer analyses indicated river flow and water temperature were the most important factors explaining variation in daily lift numbers. Other variables contributed to the regression but may be of less actual significance because of intercorrelation with flow and water temperature. Variation within lift days remains largely unexplained after examination of these variables. Shad entered the fishlift throughout daylight hours, tended to peak shortly after noon and ceased entry with the onset of darkness. Seasonal fishway induced mortalities of 2.79, 2.77, 2.90, and 3.28 percent were recorded for the four years and possible sources of mortality discussed. Daily sex ratio and mean total length by sex were also noted throughout the study.

Juvenile American shad were sampled weekly (1970-1973) by beach seine at five stations between Holyoke and Turners Falls Dams (Km 196.7) until emigration was complete. Juveniles showed consistently smaller mean total lengths toward the middle of the study area within any given week. Mean total length at emigration determined from samples passing the Holyoke Dam area ranged between 109.6 and 150.4 mm for the period 1966-1973 indicating that juveniles generally reach a greater mean length in this area than in others reported in the literature. Juvenile relative abundance was generally higher at stations located 9.2 and 29.6 km above Holyoke Dam while overall abundance appeared lower in 1972 and 1973 when fewer adults entered the study area. Upstream catch declines were first noted at water temperatures ranging between 14.2 and 15.5°C (usually reached in early October), juveniles began to leave the study area as temperatures approached 16.0°C, and emigration was generally complete when water temperature reached 10°C. Juvenile sex ratio was statistically even in

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all but one sample examined. Meristic determinations were made on 14 characters for samples of juvenile Connecticut River shad collected at Holyoke and Haddam, Connecticut (Km 32.2). Interlocation differences were not sufficient to permit useful separation of shad within the Connecticut River. (From Auth. Abstr.)

76-000440 Schuler, V. J.; Larson, L. E. (Ichthyological Assoc., Middletown, DE) IMPROVED FISH PROTECTION AT INTAKE SYSTEMS. Proc. Am. Soc. Civ. Eng., J. Environ. Eng. Div. 101 (EE6): 897-910. Dec. 1975. SFA 21(1).

Coastal fishes of Southern California can be successfully guided from an intake screenwell by means of louvers and bypassed into a holding chamber for ultimate transfer back to their natural environment. Absolute and relative velocities and directions of flows are critical, and an optimum combination of these is required for a successful system.

Velocity capped offshore intake structures offer significantly more protection to fishes than do uncapped structures. Again, direction and velocity of flow into the structure are critical, and the $\pm$ range of velocity about the mean must be minimized for continuous and predictable fish protection.

Sound as a dependable fish deterrent still appears of questionable merit. However, a pneumatic Popper did produce sufficient stimulus to reduce fish concentrations within a 10-ft (3-m) radius of the device. (Auth. Concl.)

MATHEMATICS, STATISTICAL METHODS AND MODELING

76-000441 Gatto, M.; Rinaldi, S. (Cent. Teor. Sist., C.M.R., Milano, Italy) MEAN VALUE AND VARIABILITY OF FISH CATCHES IN FLUCTUATING ENVIRONMENTS. J. Fish. Res. Board Can. 33 (1): 189-193. Jan. 1976. In English with French summ. SFA 21(1).

The mean value of the catch and its variability due to environmental fluctuations are analyzed for a very general stock-recruitment model. Particular attention is devoted to the comparison of two standard fishing strategies (constant effort and constant escapement) in terms of mean catch, variance in catches, and maximum deviation of catch. It is demonstrated analytically that constant escapement policies should always give higher mean catch, but should give higher catch variance and more extreme catches only under certain conditions of environmental variability.

76-000442 Hammond, D. E.; Lackey, R. T. (Dep. Fish. Wildl. Sci., VPI & SU, Blacksburg, VA 24061) ANALYSIS OF CATCHABLE TROUT FISHERIES MANAGEMENT BY COMPUTER SIMULATION. Trans. Am. Fish. Soc. 105 (1): 48-56. Jan. 1976. SFA 21(1).

Although strategies to meet most management objectives are relatively clearcut in single-species, catchable trout programs, strategies become much more complex when two or more species are involved. A difficult problem that must be faced in evaluating catchable trout fisheries management strategies is defining management objectives. One approach to testing alternative management strategies in complex resource systems, such as catchable trout fisheries, is systems simulation. A computer-implemented /CA/tchable /T/rout Fishery /S/imulator (CATS) was developed to evaluate fishery response under various management strategies in a multispecies stocking program. The user of CATS can select alternative management strategies and functions which generate predictions of fishing pressure in a

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particular fishery. To evaluate the effect of each system component, CATS was exercised over a wide range of potential, although entirely hypothetical, system component alternations. Predominant stocking of brook trout appreciably increased average catch per angler hour and percentage return to creel. Altering the stocking ratio to favor brown trout substantially increased the number of angler hours. Stocking predominantly rainbow trout produced results intermediate between those caused by stocking predominantly brook or brown trout. Estimates of expected angling pressure and catchability coefficients of each species stocked are of primary importance because of their considerable effect on other system components. A user must have a sound objective before deciding where, when, which species, and how many fish to plant. The primary utility of CATS is to enable the user to evaluate management strategies prior to implementation.

76-000443 Hilborn, R. (Inst. Anim. Resour. Ecol., Univ. British Columbia, Vancouver, BC V6T 1W5, Canada) OPTIMAL EXPLCITATION OF MULTIPLE STOCKS BY A COMMON FISHERY: A NEW METHODOLOGY. J. Fish. Res. Board Can. 33 (1): 1-5. Jan. 1976. In English with French summ. SFA 21 (1).

Optimal harvest rates for mixed stocks of fish are calculated using stochastic dynamic programming. This technique is shown to be superior to the best methods currently described in the literature. The Ricker stock recruitment curve is assumed for two stocks harvested by the same fishery. The optimal harvest rates are calculated as a function of the size of each stock, for a series of possible parameter values. The dynamic programming solution is similar to the fixed escapement policy only when the two stocks have similar Ricker parameters, or when the two stocks are of equal size. Normally, one should harvest harder than calculated from fixed escapement analysis.

76-000444 Jensen, A. L. (Sch. Nat. Resour., Univ. Mich., Ann Arbor 48104) RELATION BETWEEN YIELD AND FISHING MORTALITY FOR RICKER'S YIELD EQUATION. J. Fish. Res. Board Can. 33 (2): 275-277. Feb. 1976. In English with French summ. SFA 21 (1).

A method is presented that can be applied to examine the relation between yield and magnitude of fishing mortality for Ricker's dynamic pool yield equation. The magnitude of fishing mortality is measured by the norm of the vector of interval specific instantaneous fishing mortality coefficients. The method is applied to a bluegill sunfish (*Lepomis macrochirus*) population.

76-000445 Parker, F. L.; Benedict, B. A.; Tsai, C. (Vanderbilt Univ., Nashville, TN 37235) EVALUATION OF MATHEMATICAL MODELS FOR TEMPERATURE PREDICTION IN DEEP RESERVOIRS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-660/3-75-038. xvii + 205p. June 1975. SFA 21 (1).

The deep reservoir model with one-dimensional assumptions can be applied to a reservoir or lake where the principal variation of flow characteristics is in the vertical direction. Among the models evaluated, the MIT deep reservoir model appears to be most easily used and to give results most compatible with the measured temperatures. The temperature predicted is strongly dependent upon the magnitude of the absorption coefficient of water, and the diffusion coefficient. However, our sensitivity analysis shows that an absorption coefficient of about 0.75m to the -1 and a diffusion coefficient of 15 to 20 times molecular diffusion are appropriate choices for the seven TVA reservoirs studied. The determination of whether or not a reservoir model depends on the Densimetric Froude number. However, the representativeness of the result is not solely dependent upon the Densimetric Froude number. By the use of a fitted curve to the

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measured temperatures, it was possible to determine the maximum standard error of estimate for the predicted outlet level temperature, 1.6 C. Temperatures on individual days may exceed those values and they surely are exceeded at other depths in the reservoir. These limits are suggested as the limit of accuracy of these types of models.

76-000446 Royce, W. F. (NMFS, Washington, DC 20235) USE OF YIELD IN FISHERY MANAGEMENT. In P. M. Roedel, ed., Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish. Soc. Spec. Publ. No. 9: 9-12. Sept. 1974[1975]. SFA 21(1).

76-000447 Sharp, G. C.; Francis, R. C. (Scripps Inst. Oceanogr., La Jolla, CA 92037) AN ENERGETICS MODEL FOR THE EXPLOITED YELLOWFIN TUNA, /THUNNUS ALBACARES/, POPULATION IN THE EASTERN PACIFIC OCEAN. NOAA Fish. Bull. 74 (1): 36-51. Jan. 1976. SFA 24(1).

An energetics model (ENSIM) for the exploited yellowfin tuna, /Thunnus albacares/, population in the eastern Pacific Ocean is developed. Hydrodynamic properties and respiration-swimming work theory are combined to describe the energy expenditure due to swimming as a function of length for tunas. Growth and maintenance energetics are estimated and incorporated into a simplistic three process model. This model is interfaced with a population simulator (TUNPOP) and minimal energy requirements for the exploited yellowfin tuna population are derived for the simulated fishing years 1964-72. A theoretical unexploited population simulation is made, and the energy requirements by this population are compared with primary productivity rates and minimum micronekton (forage) standing stock availability. No obvious food limitation is indicated for yellowfin tunas greater than 40 cm, particularly since the exploited population is at a level of, at most, 50 percent of the unexploited biomass estimates. Population limitation processes are examined and indications that the recruitment rates are independent of exploited biomass are discussed.

76-000448 Tillman, M. F.; Stadelman, D. (NMFS, 2725 Montlake Blvd. East, Seattle, WA 98112) DEVELOPMENT AND EXAMPLE APPLICATION OF A SIMULATION MODEL OF THE NORTHERN ANCHOVY FISHERY. NOAA Fish. Bull. 74 (1): 118-130. Jan. 1976. SFA 21(1).

A computer simulation model of the reduction fishery for northern anchovy, /Engraulis mordax/, is described. The biological subroutine of this model is an age-structured paradigm which is modified to account for age-dependent exploitation and variable recruitment. To demonstrate the model's utility, two example applications are presented which provide insight into the problems of evaluating alternative regulations while lacking perfect knowledge of economic or biological behavior. The model's current value lies in its use as a tool to identify research needs.

76-000449 Walters, C. J.; Hilborn, R. (Inst. Anim. Resour. Ecol., Univ. British Columbia, Vancouver, BC V6T 1W5, Canada) ADAPTIVE CONTROL OF FISHING SYSTEMS. J. Fish. Res. Board Can. 33 (1): 145-159. Jan. 1976. In English with French summ. SFA 21(1).

This paper discusses some formal techniques for deciding how harvesting policies should be modified in the face of uncertainty. Parameter estimation and dynamic optimization methods are combined for the Ricker stock-Recruitment model to show how exploitation rates should be manipulated to give more information about the model parameters; in general, harvesting rates should be lower than would be predicted by the best fitting recruitment curve unless this curve

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predicts that the stock is very productive. A decision procedure is developed for comparing alternative stock-recruitment models; when applied to the Fraser River sockeye salmon (*Oncorhynchus nerka*), the procedure indicates that an experimental increase in escapements would be quite worthwhile. It appears that there is considerable promise for extending these methods and procedures to cases where the stock size is unknown and where fishing effort is poorly controlled.

76-000450 Youngs, W. D. (Dep. Nat. Resour., Cornell Univ., Ithaca, NY 14850) AN ANALYSIS OF THE EFFECT OF SEASONAL VARIABILITY OF HARVEST ON THE ESTIMATE OF EXPLOITATION RATE. Trans. Am. Fish. Soc. 105 (1): 45-47. Jan. 1976. SFA 21(1).

Five functional forms for the seasonal distribution of force of fishing mortality were used in determining expectations of death from fishing. Expectation of death from fishing calculated from $E/F = A/Z$ was compared to the actual expectation of death from fishing determined by numerical integration. Bias results in the formula-calculated expectation of death from fishing if the force of fishing mortality is not a constant fraction of the force of total mortality. Bias is greater when the force of fishing mortality is more asymmetrical. Bias is positive when greater force of fishing mortality occurs early in the year; negative bias occurs when force of fishing mortality is greater later in the year. The magnitude of bias, for a given functional form of force of fishing mortality, is a function of the relative size of force of fishing mortality to force of total mortality.

LAKE MANAGEMENT & RESEARCH

76-000451 Cochran, K. L. (Lake Kariba Fish. Res. Inst., Rhodesia) CATCHES OF *HYDROCYNUS VITTATUS*/ CASTELNAU DURING SARDINE FISHING OPERATIONS IN LAKE KARIABA. Trustees Natl. Mus. Monuments Kariba Stud. Pap. No. 7. [11p.] Jan. 1976. SFA 21(1).

This report is designed to document the response of the tigerfish to the establishment of the Lake Tanganyika sardine, *Limnothrissa miodon*, population and to offer some interpretations for particular features of the tigerfish catches by purse-seine net. (From Auth. Intro.)

76-000452 Green, D. M.; Smith, S. B. (Dep. Nat. Resour., N.Y. State Coll. Agric. Life Sci., Cornell Univ., Ithaca, NY) ZOOPLANKTON, ZOOBENTHOS AND FISH POPULATIONS IN CANADARAGO LAKE DURING THE INITIAL STAGES OF NUTRIENT CONTROL. N.Y. State Dep. Environ. Conserv. Tech. Pap. No. 48. ix + 105p. Mar. 1976. SFA 21(1).

The status of zooplankton, zoobenthos, fish, submergent macrophytes and fishermen characteristics are reported during the time when a 40 percent reduction in phosphorous loading by a tertiary treatment plant was initiated on a 1022 ha lake in New York.

Highest numbers (311,677/m³) of zooplankton occurred on July 6, 1973, consisting of 13 percent cladocerans, 12 percent copepods and 76 percent rotifers. Highest numbers (14,667/m²) of zoobenthic organisms occurred under the ice in February 1973. Chironomids (49.7 percent) and oligochaetes (45.6 percent) made up the majority of numbers found throughout the sampling period. Dense populations of forage and panfish were present. Yellow perch was the most abundant fish (371 fish/ha & 14.5 kg/ha in 1972 and 808 fish/ha & 45.7 kg/ha in 1973). Sparse predator populations consisted of smallmouth bass, chain pickerel and largemouth bass (6 fish/ha & 2.8 kg/ha in 1972 and 7.2

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fish/ha & 2.8 kg/ha in 1973).

Exploitation rates of smallmouth and largemouth bass was 29.6 and 12.5 percent, respectively. Fishing effort was 27 hours/ha and most anglers fished from boats. Shore fishermen achieved the highest total catch rate. Important species in the catch were smallmouth bass, crappie, perch and brown bullheads with smallmouth bass the preference of anglers. Fishing was characterized as "poor" by interviewed fishermen.

Submergent aquatic plants are sparse compared to 1935 and the reduction in amount of plants may be due to reduced water clarity.

Some changes have occurred in the species present since 1935. Population levels were probably similar. Growth rate of predators has improved since 1935 but remained similar for perch. Pickerel, perch and bullheads were the important species in the angler catch in 1935.

This report describes the baseline biological conditions before the effects of the new wastewater treatment facility became evident and represents the first phase of this investigation. A time lag is required after the new facility has been operating in order to fully evaluate its effects. This is intended to be reported in a later publication. (From Auth. Abstr.)

76-000453 Jaiyen, K. THE HISTORY AND IMPORTANCE OF THE RAINBOW SMELT, /OSMERUS MORDAX/ (MITCHILL), IN THE LAKE MICHIGAN FISH COMMUNITY, WITH SPECIAL REFERENCE TO ITS MANAGEMENT AS A RESOURCE. Ph. D. dissertation, Univ. Mich. 166p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(6), 1975. SFA 21(1).

The rainbow smelt, /*Osmerus mordax*/ (Mitchill), was first introduced into the upper Great Lakes basin in the early 1900's, primarily as an additional food source for the introduced Atlantic salmon (/Salmo salar/). Its dispersal, which began in Lake Michigan in the early 1920's from a population introduced into Crystal Lake, Benzie County, Michigan, throughout the upper Great Lakes has caused a great deal of controversy for its possible adverse effects on the native fishes. At the same time it has been preyed upon considerably by many native piscivorous fishes, including the highly valued lake trout (/Salvelinus namaycush/), and has been harvested intensively by both commercial and sport fishermen until the late 1950's. In this study an attempt was made to clarify this controversy, and to determine whether or not this fish should be managed.

Included in this study are the history of introduction and dispersal, fisheries, population condition, some aspects of life history (habitat and seasonal distribution, food habits, and biotic potential), and the evaluation of ecological roles of smelt in the Lake Michigan ecosystem. This study was based mainly on information from previous studies and the analyses of data collected by various federal and state agencies. A framework for decision making for management of a fish species was established. Three criteria were formed which included /the importance of a fish species/ (economically, biologically, and taxonomically or naturally), /population condition/, and /management feasibility/; and the types of information required at each of these criteria were identified.

From the available information it was concluded that the smelt in Lake Michigan was a moderate economic importance by providing sizable catches to both commercial and sport fisheries, and it has a high biological importance to the Lake Michigan fish community by serving as a forage base. The smelt population is increasing and is presently under-exploited by the commercial fishery. However, a management program aiming to expand the utilization of the smelt population was not proposed due to 1) the presently low market demand of smelt, 2) an expected increase in fishing pressure from the existing commercial fishermen and new-coming sport fishermen as the demand of smelt increases in the future, and 3) greater predation on smelt by

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salmonids as programs to restore the fisheries of the Great Lakes become more progressive. Nevertheless, liberal commercial catch quotas and allowance of mid-water and bottom trawls in the fishery were recommended. In the event that the requirements of forage base by salmonids increase, possible cut back of these quotas should be considered.

76-000454 Kempinger, J. J.; Churchill, W. S.; Priegel, G. R.; Christenson, L. M. (Wis. Dep. Nat. Resour., Madison 53701) ESTIMATE OF ABUNDANCE, HARVEST, AND EXPLOITATION OF THE FISH POPULATION OF ESCANABA LAKE, WISCONSIN, 1946-69. Wis. Dep. Nat. Resour. Tech. Bull. No. 84. 30p. 1975. SFA 21(1).

A complete compulsory creel census was conducted on 293-acre Escanaba Lake, northern Wisconsin from 1946 through 1969. On the average each year, anglers fished 65 hours per acre catching 20 lb/acre at the rate of 0.84 fish per hour. Population estimates of the principal sport species were made from 1956 through 1969. The spring standing crop varied annually from 19 to 117 lb/acre.

Walleyes, though not native, were the most important species, contributing 36 percent by weight of the harvest during this period. Standing crops and harvest of panfish, especially yellow perch and pumpkinseed, fluctuated greatly; those of predator fishes were more stable.

The exploitation rate for each species varied greatly from year to year but not significantly from the mean which was established over a number of years and is characteristic for each species. Northern pike (.46) and bluegill (.42) were the most heavily exploited, and yellow perch (.15) the most lightly. No relation could be demonstrated between rate of exploitation and other aspects of the fishery.

Species composition of the estimated spring standing crop and of the harvest was similar. Large fluctuations in the proportion of the various species occurred; but these were not thought to be the result of liberalized fishing regulations in effect on the lake.

The decline of panfish in the late 1950's and early 1960's is attributed to the increased predator species component during that period.

76-000455 Leach, J. H.; Nepszy, S. J. (Ontario Minist. Nat. Resour., Lake Erie Fish. Res. Stn., Wheatley, ON N0P 2P0, Canada) THE FISH COMMUNITY IN LAKE ERIE. J. Fish. Res. Board Can. 33 (3): 622-638. Mar. 1976. In English with French summ. SFA 21(1).

Lake Erie, because of its shallowness and the fertility of its drainage basin, is the most productive of the Laurentian Great Lakes. The fish community is diverse (114 species representing 24 families) and is dominated by mesothermal and warmwater species. Although commercial fish production has been fairly consistent (average annual yield of 23,000 metric tons since 1915) there has been a dramatic change in species composition during the last 150 yr. Lake sturgeon, lake trout, lake herring, lake whitefish, sauger, and blue pike have virtually disappeared. Commercial production of medium-priced species such as yellow perch and white bass has increased and lower-valued species such as rainbow smelt, alewife, and freshwater drum have become more dominant in the fishery. The cultural stresses deemed largely responsible for these changes are, in approximate order of effect, an intensive commercial fishery, nutrient loading, the introduction of nonnative species, tributary and shoreline restructuring, erosion and siltation, and the introduction of toxic materials. The effects of these stresses on the environment and species composition are discussed.

The current status and future of the remaining commercial species are considered in the light of past and present effects of the

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cultural stresses. The joint efforts of the United States and Canada to improve water quality and to control and reduce nutrient loading should lead to an improvement in the environment in the near future. Lake Erie is well suited for the production of valuable percid species but unless a strong effort is made to regulate exploitation the future of the commercial fishery is precarious.

RIVER AND STREAM MANAGEMENT & RESEARCH

76-000456 Funk, J. L. (Mo. Dep. Conserv., Jefferson City 65101) THE FISHERY OF BLACK RIVER, MISSOURI 1947-1957. Mo. Dep. Conserv. Aquatic Ser. No. 12. 22p. Jan. 1975. SFA 21(1).

The fish population of Black River was sampled three times annually, 1947-57, at two stations. Twenty-seven species of larger fish (greater than 1/2 oz) and 50 species of smaller fish were collected at the upper station with species characteristic of the Ozarks predominating. Forty-two species of larger fish and 54 species of smaller fish were taken at the lower station, with a mixture of Ozark and Lowland species predominating. Growth of smallmouth bass, longear sunfish, and green sunfish at the upper station was faster than average for headwater streams. Rock bass growth at both stations was slow as was gizzard shad growth at the lower station. A creel census indicated higher fishing success in the upper Black River watershed than in the Ozark Highland area as a whole. Fishing success in the lower Black was somewhat higher than in the upper Black and substantially higher than in the Southeast Lowland area as a whole. The fishery in Black River is influenced by migration of fish produced in Clearwater Reservoir into the river. A very large year class of smallmouth bass was produced in Black River in 1952, apparently due to low, stable water conditions associated with drought. (RS)

76-000457 Gerstung, E. R. (Calif. Fish Game, Sacramento 95814) CALIFORNIA WILD TROUT MANAGEMENT PROGRAM: HAT CREEK MANAGEMENT PLAN. Calif. Dep. Fish Game 53p. Sept. 1975. SFA 21(1).

To perpetuate optimum populations of wild trout in lower Hat Creek for the use and enjoyment of the angling public and to insure that trout habitat in lower Hat Creek will be maintained and improved, the Department of Fish and Game recommends that:

I. Pacific Gas and Electric Company continue to manage the Hat Creek wild trout area for public use with a minimum of inconveniences other than those needed for access, sanitation, safety and protection of the land.

II. A pilot fencing project be initiated to determine whether cattle fencing is a feasible method of improving trout production and arresting stream bank damage resulting in the sloughing of undercut banks. The scheduling of this project will be dependent on adequate funding. If the pilot fencing project proves to be effective and feasible, a full-scale stream fencing program should be considered.

III. Pacific Gas and Electric Company be encouraged to retain ownership of property within the wild trout area. Lassen National Forest and the Bureau of Land Management should retain lands adjacent to Pacific Gas Electric Company lands to buffer the wild trout area from developments that would be inconsistent with wild trout management objectives.

IV. Coordination be maintained between all agencies whose activities could directly or indirectly affect the wild trout area.

V. Waste discharges and projects which could adversely affect water quality in the wild trout area be prohibited. Potential contaminants include algicides, pesticides and herbicides, solid wastes, treated

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domestic effluent, fertilizers, mining wastes and turbidity from upstream activities.

VI. Periodic population sampling and creel census be conducted to determine whether management plan objectives are being met. (From Auth. Recomm.)

76-000458 Hames, R. L., ed. (Dep. Environ. Prot., Hartford, CT) A GENERAL SURVEY OF THE FISHERIES RESOURCES OF THE THAMES RIVER WATERSHED, CONNECTICUT. Univ. Conn. Stn. Agric. Exp. Stn. Bull. 435. ii + 110p. May 1975. SFA 21(1).

The Thames River system is located in a section of southern New England that has escaped the extreme alterations of the industrial revolution and later urbanization. It has, unfortunately, suffered the consequences of dam construction causing the disappearance of anadromous fish, and industrial and domestic pollution which degraded water quality in some areas to a marginal fisheries habitat. Enough unspoiled areas are left, unaltered by dams, pollution and the developer, to reward the knowledgeable observer with a glimpse of what it was and what it could be again.

As part of the program for restoration of anadromous fish to the Thames River system, it was decided to make a general biological survey of the system to document present conditions. This included predictions of anadromous runs, comparisons of various habitat types, investigation and monitoring of pollution and its effect on fish and the aquatic environment and a survey of the various pathogens present in the fish population. (From Ed. Forward)

76-000459 Platts, W. S. GEOMORPHIC AND AQUATIC CONDITIONS INFLUENCING SALMONIDS AND STREAM CLASSIFICATION IN THE SALMON RIVER DRAINAGE, IDAHO, 1970-1972. Ph.D. dissertation, Utah State Univ. 231p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(1), 1975. SFA 21(1)

Investigations were conducted from July, 1970, through September, 1972, of (1) the physical structure of aquatic environments in granitic, mountainous lands, (2) the relationship between physical stream structure and fish populations, (3) the influence of geomorphic process on aquatic ecosystems, (4) the order of landforms in relation to uniformity in aquatic environments, and (5) the potential for classifying aquatic environments from land classification systems. Within a 397 square mile area, stratified into four geologic process groups and 12 geomorphic types, 38 streams in the upper South Fork Salmon River watershed, were studied by analyzing 2,482 transects for physical aquatic and streambank environment and 291 areas for fish populations.

Streams demonstrated distinguishing features which result from the structure of the stream being influenced by geomorphic process; therefore, there is uniformity in streams draining similar lands formed by similar process. The findings should allow classification of the aquatic environments within the granitic areas of the Idaho Batholith to the geologic process group level and some environments to the geomorphic type level. Some areas of the streams are dominated by one type of external variable, such as glaciation. However, multivariate control from geomorphic processes is predominant in influencing stream conditions. Certain aquatic structural characteristics control the density of fish populations and fish species composition. Of these, stream depth, stream width, and elevation of the stream channel are the most important. Salmonids are adapted to almost all streams in these high elevation granitic lands. No correlation was found between variations in water chemistry and density of fish populations. Spatial differences in dissolved and suspended substances appeared to be dependent on the degree of

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decomposition of bedrock and possibly the elevation of the channel; time, as related to stream-flow movement through the drainage, has little influence.

Total density of fish populations decreases or increases in a uniform manner with most changing variables of the aquatic structure. However, some individual fish species responded in an opposite manner, and certain species showed to relationship. Many direct relationships exist between the variables describing the structure of the study streams; if one changing variable is identified, most other structural variables will respond in a set manner.

FARM POND AND SMALL IMPOUNDMENT MANAGEMENT

76-000460 Gipson, P. S.; Feit, D. E.; Morris, J. W. (Nebr. Game Parks Comm., 2200 N. 33rd St., P.O. Box 30370, Lincoln 68503) POND FOR NEBRASKANS. Nebr. Game Parks Comm., Lincoln 14p. 1975. SFA 21(1).

A popularly-written guide to farm pond design and management. (RS)

LARGE IMPOUNDMENT MANAGEMENT & RESEARCH

76-000461 Kenmuir, D. H. S. (Lake Kariba Fish. Res. Inst., Rhodesia) FISH SPAWNING UNDER ARTIFICIAL FLOOD CONDITIONS ON THE MANA FLOOD-PLAIN, ZAMBEZI RIVER. Trustees Nat. Mus. Monuments Kariba Stud. Pap. No. 6. 12p. Jan. 1976. SFA 21(1).

Investigations were undertaken at the Mana Pools flood-plain to determine whether or not the fish population was able to utilize artificial flood conditions, engendered by releases from the Kariba Dam Wall, for spawning purposes. Juvenile fish of several species were recovered from isolated pools following closure of two floodgates on the first visit, while the second visit showed that opening of two floodgates initiated movement by sexually active fish of several species into flooded areas. There was a close correlation between juvenile species found on the first visit and sexually active fish found moving into flooded areas on the second visit. The conclusion drawn was that fish were able to successfully utilize artificial flood conditions for spawning purposes. (Auth. Summ.)

76-000462 Walburg, C. H. (U.S. FWS, North Cent. Reservoir Invest., Yankton, SD 57078) CHANGES IN THE FISH POPULATION OF LEWIS AND CLARK LAKE, 1956-74, AND THEIR RELATION TO WATER MANAGEMENT AND THE ENVIRONMENT. U.S. Fish Wildl. Serv. Res. Rep. 79: iv + 34p. 1976. SFA 21(1).

Lewis and Clark Lake, an 11,300-ha main stem Missouri River reservoir at the boundary of Nebraska and South Dakota, is managed by the U.S. Army Corps of Engineers for flood control, hydroelectric power, navigation, and other purposes. Annual sampling of the reservoir fish population in 1956-74 indicated that fish abundance decreased about 66 percent and the number of species about 20 percent between 1956, the first year of impoundment, and the early 1970's. Poor fish reproduction and decreasing recruitment to adult stocks were caused by the regimen of water management and related shoreline modification. Low and fluctuating water levels during May and June were detrimental to fish spawning and survival of young. The water exchange time decreased from 10 days during the early years of impoundment to 4 or 5 days in 1969-72. The river-like downstream water

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currents associated with short water exchange times were harmful to the fish population, partly because large numbers of young of the year were lost from the reservoir in the discharge. This loss of young not only decreased the potential abundance of adults of these species, but also had a detrimental effect on the growth and survival of predator species for which they served prey. Erosion of shorelines and deposition of silt in the upstream end of the reservoir eliminated many areas formerly used for spawning.

With the present water management regimen, fish abundance in Lewis and Clark Lake will probably remain similar to that in the early 1970's. The fish population is expected to be dominated by freshwater drum, *Aplodinotus grunniens*; channel catfish, *Ictalurus punctatus*; sauger, *Stizostedion canadense*; river carpsucker, *Carpiodes carpio*; white bass, *Morone chrysops*; and emerald shiner, *Notropis atherinoides*. Suggested management measures that might improve sport fish abundance, such as construction of spawning and nursery ponds adjacent to the reservoir or the maintenance of high reservoir water levels during May and June to enhance reproduction of desirable species, are either too costly to be currently undertaken or are inconsistent with the primary flood-control function of the reservoir.

MARINE MANAGEMENT & RESEARCH

76-000463 Pedersen, M. G. (Wash. Dep. Fish., 115 General Administration Bldg., Olympia 98504) RECENT INVESTIGATIONS OF PETRALE SOLE OFF WASHINGTON AND BRITISH COLUMBIA. Wash. Dep. Fish. Tech. Rep. 17. viii + 72p. Nov. 1975. SFA 21(1).

Assessment was made of the state of various stocks of petrale sole (*Eopsetta jordani*) of Washington and British Columbia, Canada, by examination of biological parameters and recent trends in catch and effort.

The recruitment pattern in recent years has been variable, but quite similar to both the northern and southern stocks, with the year classes of 1962 and 1966-1968 being moderate to strong within each stock. The variation in recruitment was reflected in production trends over the last 2 decades. From the age-length structure of the commercial catch, von Bertalanffy growth parameters were determined for the summer inshore and winter spawning groups of the Esteban and Cape Flattery Spit stocks. A model was proposed to describe the maturity structures of two stocks. Estimated size at 50 percent maturity corresponded to a latitudinal trend, i.e., maturation occurred at a smaller size in southern waters.

Several methods were employed to estimate the total mortality coefficient (Z). Estimates for males and females of the Esteban stock were 1.00 and 0.70, respectively, and for the Cape Flattery Spit group, corresponding values were 0.90 and 0.60. The difference between stocks was attributed to natural mortality since Z did not vary with fishing effort.

Yield per recruit models of the summer inshore fisheries on both stocks did not suggest the stocks were being overfished. In theory, increases in yield could be obtained from both stocks if age at entry was lowered and fishing effort increased. However, such changes would not be economical in the multi-species trawl fishery.

Regulation of the trawl fishery with respect to petrale sole is discussed under present conditions of markets and fishing operations. Future programs of research should focus on improving sampling inadequacies and monitoring production, effort, and changes in vessel efficiency.

76-000464 Pinhorn, A. T. (ed.) (Fish. Mar. Serv., Biol. Stn., St. John's, NF A1C 5X1, Canada) LIVING MARINE RESOURCES OF NEWFOUNDLAND-LABRADOR: STATUS AND POTENTIAL. Bull. Fish. Res. Board Can. 194. ix + 64p. 1976. In English with French summ. SFA 21(1).

Knowledge on the marine fisheries resources of Newfoundland and Labrador to 1964 was summarized in Bulletin 154 of the Fisheries Research Board of Canada. Additional information, which has become available since that time, is summarized here. Scientific basis for regulating and managing the international fisheries in the Newfoundland and Labrador area through the International Commission for the Northwest Atlantic Fisheries (ICNAF) is also discussed.

Current information is presented for all species that presently support or have potential for supporting commercial fisheries in the area. Detail given varies depending on the present extent of knowledge and previous coverage of the species. It is presented on a species-by-species basis and, when possible, on a stock-by-stock basis within species. Pertinent information is given on the distribution, abundance, general biology, and fishery of each species, especially where this was not previously covered. Also, since in the late 1960s and early 1970s regulations of one form or another have been introduced for many species, an extensive treatment of the management regime for such species is presented. Potential for increased catches from all these resources is summarized.

76-000465 Radovich, J. (Calif. Dep. Fish Game, Sacramento 95814) APPLICATION OF OPTIMUM SUSTAINABLE YIELD THEORY TO MARINE FISHERIES. In P. M. Roedel, ed. Optimum Sustainable Yield as a Concept in Fisheries Management. Am. Fish Soc. Spec. Publ. No. 9: 21-28. Sept. 1974[1975]. SFA 21(1).

Even though maximum sustainable yield can be precisely defined, for a number of reasons, which have been given, it may be quite meaningless in many ocean fisheries. Maximum economic yield has an advantage over maximum sustainable yield in that it occurs at a larger population size. This gives a greater protection against the possibility of overfishing, but it suffers from most of the inadequacies of maximum sustainable yield since it usually superimposes economic values over a maximum sustainable yield model. Despite the faults of both of these concepts, they can be precisely defined.

Optimum sustainable yield, on the other hand, has no precise definition. It must be arrived at by some subjective decision, usually involving sociological and emotional concepts. "Quality of life," for instance, cannot be defined by logical positivism in a purposive rational manner. "Satisfactory sport" may not be empirically definable either.

I would suggest, therefore, that the term "optimum sustainable yield" be de-emphasized along with maximum sustainable yield and maximum economic yield, since the yield in most cases would be anything but sustainable, and replace it with the concept of managing on the basis of sustaining an "optimum population size." The "optimum population size" would be that size necessary to produce satisfactory fishing success. The concepts of "satisfactory fishing success" as well as "optimum population size," of necessity, must be arrived at subjectively. These values must be responsive to the needs and feelings of society and, therefore, they must be subject to change over time. (Auth. Summ.)

SPORT FISHERY ABSTRACTS

76-000466 Sargent, M. C., ed. SYMPOSIUM: OCEANOGRAPHY AND FISHERIES OF BAJA CALIFORNIA WATERS. Calif. Coop. Oceanic Fish. Invest. Rep. 17: 59-128. Oct. 1974. SFA 21(1).

A collection of eight papers, four in Spanish with English summaries only.

UTILIZATION OF FISHERY PRODUCTS

76-000467 Iredale, D. G.; York, R. K. (Fish. Mar. Serv., Freshwater Inst., Winnipeg, MB R3T 2N6, Canada) PURGING A MUDDY-EARTHY FLAVOR TAINT FROM RAINBOW TROUT (/SALMO GAIARDNERI/) BY TRANSFERRING TO ARTIFICIAL AND NATURAL HOLDING ENVIRONMENTS. J. Fish. Res. Board Can. 33 (1): 160-166. Jan. 1976. In English with French summ. SFA 21(1).

Studies were conducted to determine the length of time required to purge a muddy-earth flavor taint from pond cultured rainbow trout (/Salmo gairdneri/) transferred to two different clear water environments. Sensory data from trained judges show that this required 5 days for fish transferred to a rapidly changing purified artificial water environment and 16 days for fish transferred to a relatively static natural water environment to reduce this taint to or below threshold levels of recognition.

76-000468 Maligalig, L. L.; Caul, J. F.; Bassette, R.; Tiemeier, O. W. (Dep. Nutr., Univ. Guelph, Guelph, ON, Canada) FLAVORING LIVE CHANNEL CATFISH (/ICTALURUS PUNCTATUS/) EXPERIMENTALLY. EFFECTS OF CONCENTRATION AND EXPOSURE TIME. J. Food Sci. 40: 1242-1245. 1975. SFA 21(1).

The rapid rate that live channel catfish absorb flavors from their environment, as shown by our experiments, emphasizes that rigid quality control measures are needed in the catfish industry to prevent off-flavors. Likewise, live channel catfish may be exposed to potentially beneficial solutions, i.e., smoke, garlic, and others, to produce a variety of flavors desired by consumers. (From Auth. Results and Discuss.)

76-000469 Maligalig, L. L.; Caul, J. F.; Bassette, R.; Tiemeier, O. W. (Dep. Nutr., Univ. Guelph, Guelph, ON, Canada) FLAVORING LIVE CHANNEL CATFISH (/ICTALURUS PUNCTATUS/) EXPERIMENTALLY. EFFECTS OF REFRIGERATED STORAGE AND OF PURGING ON RETENTION OF EXPERIMENTAL FLAVORS. J. Food Sci. 40: 1246-1248. 1975. SFA 21(1).

It was found that experimental flavors are easier to produce in channel catfish than to get rid of. As absorption of flavors varied with flavorants (more 2-pentanone was absorbed than dimethyl sulfide), so did purging rates. Purging rates of our off-flavors varied according to initial off-flavor intensities. Density of fish population and flow rate of clean water in purging tanks probably affect purging rates, but such purging studies have not yet been carried out. Potential sources of off-flavors should be known so measures to prevent their development and to purge fish of them may be used. (From Auth. Results and Discuss.)

SPORT FISHERY ABSTRACTS

76-000470 Tabachek, J. L.; Yurkowski, M. (Fish. Mar. Serv., Freshwater Inst., Winnipeg, MB R3T 2N6, Canada) ISOLATION AND IDENTIFICATION OF BLUE-GREEN ALGAE PRODUCING MUDDY ODOR METABOLITES, GEOSMIN, AND 2-METHYLISOBORNEOL, IN SALINE LAKES IN MANITOBA. J. Fish. Res. Board Can. 33 (1): 25-35. Jan. 1976. In English with French summ. SFA 21(1).

Eleven axenic or unialgal cultures of blue-green algae, 10 producing geosmin (/trans/-1, 10-dimethyl-/trans/-9-decalol) and 1 producing 2-methylisoborneol (2-/exo/-hydroxy-2-methylbornane) were isolated from saline lakes in southwestern Manitoba. These compounds are responsible for the muddy flavor in fish and water in some lakes. Algae producing geosmin were /Oscillatoria/ cf. /prolifera/ (Greville) Gomont, /O. tenuis/ Agardh, /O. cf. /cortiana/ Meneghini, /O. cf. /variabilis/ Rao, /O. agardhii/ Gomont, /O. cf. /splendida/ greville, /O. sp., /Symploca/ cf. /muscorum/ (Agardh) Gomont, /Lyngbya/ cf. aestuarii/ (Mertens) Liebman, and /L. sp. /Lyngbya/ cf. /cryptovaginata/ Schkornbatov is the first alga reported to produce 2-methylisoborneol.

Actinomycetes, which are known to produce these muddy flavor compounds, were not detected in these lakes.

MISC. TECHNIQUES AND EQUIPMENT

76-000471 Lord, G.; Acker, W. C.; Hartt, A. C.; Rothschild, B. J. (Fish. Res. Inst., Univ. Wash., Seattle 98195) AN ACOUSTIC METHOD FOR THE HIGH-SEAS ASSESSMENT OF MIGRATING SALMON. NOAA Fish. Bull. 74 (1): 104-111. Jan. 1976. SFA 21(1).

A system of free-floating acoustic buoys with upward-looking transducers has been developed for use in assessing high-seas salmon stocks. The transducers, operating at 120 kHz, are suspended 46 m below the surface. The fish counts and the range to each fish are obtained in digital form, and the data are radioed from each buoy to the tending vessel where the data are decoded and recorded on magnetic tape. The present system consists of four buoys although the receiver-decoder system can accommodate up to 10 buoys operating synchronously.

76-000472 Peterson, M. L.; Clay, C. S.; Brandt, S. B. (Gulf Oil Corp., New Orleans, LA 70160) ACOUSTIC ESTIMATES OF FISH DENSITY AND SCATTERING FUNCTION. J. Acoust. Soc. Am. 59 (Suppl. No. 1): 74. 1976. Abstract only. SFA 21(1).

The signal processing techniques for acoustically estimating fish abundance are echo counting and echo integration. The transducer beam pattern complicates these estimates. We (1) statistically model the effects of the beam pattern on scattered signals, (2) compare acoustic data to this model, and then (3) for echo from individual fish, calculate estimates of fish density and scattering function based on these comparisons. At low densities we determine the proportionality constant relating the average echo integral and fish densities. Then at high densities, this proportionality is used to estimate fish density. The theory is compared to experimental data for alewife in Lake Michigan, U.S.A.

SPORT FISHERY ABSTRACTS

76-000473 Smith, P. E. (NMFS, Southwest Fish. Cent., La Jolla, CA 92038) ACOUSTIC CHARACTERISTICS OF POPULATIONS OF EPIPELAGIC SCHOOLING FISH. J. Acoust. Soc. Am. 59 (Suppl. No. 1): 74. 1976. Abstract only. SFA 21(1).

Pelagic schooled fish populations have acoustic characteristics derived from their individual reflection or backscattering properties, their tendency to school, the tendency of schools to be aggregated in groups, and the tendency for populations of different species to be aggregated in regions of high productivity. In addition to those static properties, the different species populations can be expected to have characteristic swimming and feeding behavior at the individual level and foraging behavior at the school level. Schooling-level foraging behavior is affected by the fact that a school of fish eats far more than is produced per unit of school area. The foraging behavior of schools is expressed as the number of unit areas to be grazed per unit of school area. For example, a moderately compact school of anchovy (0 dB target strength) might contain 15 kg of fish per square meter of sea surface. Food requirements of such an aggregation probably exceed 40 g C/m²/day but primary productivity of the northern anchovy is only of the order of 0.5 g C/m²/day. Therefore, an individual anchovy school must cover a minimum of 80 times its own area each day. Other fish species appear to school in less compact schools and probably have other food requirements. Schooling and foraging behavior also differs by day and night. Work in California waters has demonstrated acoustical techniques for the estimation of fish size and school motion. These acoustic parameters remain to be combined with static and dynamic, biological and geographic knowledge of fish populations to provide practical acoustic means of fish target identification. Similarly, the acoustic characterization of water masses and particularly the distribution and abundance of epipelagic schooled fish targets which we are investigating appear to be lacking for most of the world ocean in the upper 100 m.

76-000474 Thorne, R. E. (Coll. Fish., Univ. Wash., Seattle 98195) DETECTION AND QUANTIFICATION OF FISH POPULATIONS BY ULTRASONIC ECHO RANGING. J. Acoust. Soc. Am. 59 (Suppl. No. 1): 73. 1976. Abstract only. SFA 21(1).

The discovery that fish schools could be detected by ultrasonic echo ranging led to early utilization of hydroacoustic equipment by fisherman and fisheries scientists. However, the full potential of ultrasonic echo ranging for quantitative fisheries investigations has only recently begun to be realized. At the University of Washington a concerted effort to develop and apply hydroacoustic methods in the study of fish populations was initiated in the late 1960's. Investigations have been conducted on the relationship between echo intensity and fish abundance and on scattering characteristics of fish targets. Equipment and techniques which were developed as part of this research are now being applied by fisheries managers on several fish stocks in the northeastern Pacific and in scientific investigations of the role of fish in both freshwater and marine ecosystems.

76-000475 Trout, G. C. (Fish. Lab., Lowestoft, England) PROCEDURES FOR RESEARCH VESSEL DESIGN. Minist. Agric. Fish. Food, Fish. Invest. Ser. II 27 (10): vii + 33p. 1975. SFA 21(1).

This paper suggests an approach philosophy to be used during the compilation of a brief for the Consultant Naval Architect who is selected to undertake the integration of the complex design requirements for a modern fisheries research vessel.

The process of planning and building the Lowestoft Laboratory's /Cirolana/ is used to illustrate some aspects of that approach and the

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outcome of some of the special measures taken.

76-000476 Weber, C. I. (U.S. EPA, Cincinnati, OH 45268) DESIGN OF AN EPA COMPUTER-BASED SYSTEM FOR THE STORAGE, RETRIEVAL AND ANALYSIS OF DATA ON COMMUNITIES OF INDIGENOUS AQUATIC ORGANISMS. Presented at the 24th Annu. Meeting, N. Am. Benthol. Soc., La Crosse, Wis., March 24-26, 1976. Mar. 1976. SFA 21(1).

A computerized data handling system (called BIO-STORET) is currently being developed to accommodate all biological field and laboratory data generated by the US Environmental Protection Agency and other Federal, State and local programs conducting inland, estuarine and marine water quality monitoring, discharge permit compliance monitoring, and studies of the effects of heated water discharges and ocean disposed wastes, required by the 1972 Amendments to the Federal Water Pollution Control Act (Public Law 92-500). Communities of indigenous aquatic organisms covered by this system include: phytoplankton, zooplankton, meroplankton, periphyton, macrophyton, macroinvertebrates and fish. Types of data that will be stored by the system include: (1) COMMUNITY STRUCTURE--species composition and community diversity, (2) STANDING CROP--numbers (population density) and biomass, (3) COMMUNITY FUNCTION AND CONDITION--rates of physiological processes such as photosynthesis, respiration and nitrogen fixation; the concentration of metals, pesticides and other toxic substances in the tissues of aquatic organisms; and histopathological conditions, and (4) BIOASSAY--algal assay (algal growth potential) and laboratory and /in situ/ bioassays using macroinvertebrates, fish and other aquatic organisms.

The system will function as a companion to the EPA physical and chemical water quality data storage and retrieval system commonly known as the Water Quality File (STORET) and will be accessed by the same telecommunications network. BIO-STORET will utilize SYSTEM 2000, a generalized data base management software package marketed by MRI Systems Corporation, Austin, Texas, and is scheduled to become operational in mid-1976.

REVIEWS, BIBLIOGRAPHIES, ETC.

76-000477 Environment Canada (Fish. Mar. Serv., Office of the Editor, 116 Lisgar St., Ottawa, ON K1A 0H3, Canada) SIXTEENTH SUPPLEMENT TO LIST OF ARTICLES IN THE TRANSLATION SERIES NO. 3326-3625 (WITH INDEXES TO AUTHORS AND TO TRANSLATORS). Environ. Can., Fish. Mar. Serv. Transl. Ser. 41p. Jan. 1976. SFA 21(1).

The following translations have been prepared by or for the Fisheries and Marine Service, for use in their investigations. Copies are available from Translation Services, Canada Institute for Scientific and Technical Information, National Research Council of Canada, Ottawa, Ontario K1A 0S2, at a cost of twenty cents per page, with a minimum charge of two dollars. Do not send payment with your request, an invoice will accompany the translation when it is sent to you. Information on translations generally may be obtained from the Department of the Environment, Fisheries and Marine Service, Office of the Editor, Ottawa, Ontario K1A 0H3. (From Auth. Preface)

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76-000478 Environmental Protection Agency (U.S. EPA, Office Res. Develop., Cincinnati, OH 45268) ORD PUBLICATIONS SUMMARY. U.S. Environ. Prot. Agency EPA-600/9-76-013a. vii + 235p. Mar. 1976. SFA 21(1).

This is the fifth issue of the Office of Research and Development's (ORD's) quarterly ORD PUBLICATIONS SUMMARY. This Summary is intended to provide a current listing (since July 1973) of ORD's final reports on in-house, grant, contract, and interagency projects. A New Report Abstracts Section is included in the Summary to provide brief abstracts of recently printed reports, as well as indices by Title, Subject Area, Performing Organization, Personal Author, Report Number, and Grant, Contract, or Interagency Agreement Number to aid the reader in identifying reports of interest. Instructions on how to order copies of reports are on the inside of the front cover. (From Auth. Foreward)

76-000479 Horseman, L. C.; Kernehan, R. J. (Ichthyoclogical Assoc. Inc., R.D. 1, Box 286, Middletown, DE 19709) AN INDEXED BIBLIOGRAPHY OF THE STRIPED BASS, /MORONE SAXATILIS/ 1670-1976. Ichthyol. Assoc., Inc., Bull. 13: 118p. 1976. SFA 21(1).

The publication contains 1505 references to the striped bass. (RS)

WATERSHED MANAGEMENT

76-000480 Mangum, F. A. ANALYSIS OF MACROINVERTEBRATE SAMPLES FROM TEN ROCKY MOUNTAIN STREAMS. Ph.D. dissertation, Erigham Young Univ. 272p. 1975. From Diss. Abstr. Int. B Sci. Eng. 36(8), 1976. SFA 21(1)

This study was an attempt to evaluate the effects on ten Rocky Mountain streams from management activities on U.S. Forst Service Lands. Macroinvertebrate and water chemistry data were collected. Data analysis methods included: three diversity indices, a numerical taxonomy system of multivariate statistical analysis, numbers and biomass per selected taxa, percent composition per order, and total numbers and biomass. None of the methods of analysis were found to be adequate if used alone, but by using a combination of dendograms, biomass, and numbers data in addition to the diversity indices (SCI and bar d) stream stress could be detected. Although organic water pollution generally did not reach levels of concern, other forms of stress, such as siltation and altered flows, became evident upon data analysis. In general, stream insect communities studies showed quick recovery from short-term stresses but definite negative responses to chronic stresses.

76-000481 Omernik, J. M. (U.S. EPA, Corvallis Environ. Res. Lab., Corvallis, OR 97330) THE INFLUENCE OF LAND USE ON STREAM NUTRIENT LEVELS. U.S. Environ. Prot. Agency Ecol. Res. Ser. EPA-600/3-76-014. viii + 106p. Jan. 1976. SFA 21(1).

National Eutrophication Survey (NES) data for 473 non-point type drainage areas in the eastern United States were studied for relationships between drainage area characteristics (particularly land use) and nutrient levels in streams. Both the total and inorganic forms of phosphorus and nitrogen concentrations and loads in streams were considered.

Mean nutrient levels were considerably higher in streams draining agricultural watersheds than in streams draining forested watersheds. The levels were generally proportional to the percentages of land in agriculture, or the combined percentages of agricultural and urban

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land use. Variations in nutrient loads (exports) in streams, associated with differences in land use categories, were not as pronounced as the variations in nutrient concentrations. This was apparently due, in large part, to differences in areal stream flow from different land use types.

Regression analyses of the combined percentages of agricultural and urban land uses against both the total and inorganic forms of phosphorus and nitrogen were performed. Equations for these analyses, together with maps illustrating the equations' residuals, offer a limited predictive capability and some accountability for regional characteristics. (From Atuh. Abstr.)

WATER USE AND CONSERVATION

76-000482 Hauck, F. R.; Edson, Q. A. (FPC, Washington, D.C. 20426) PUMPED STORAGE: ITS SIGNIFICANCE AS AN ENERGY SOURCE AND SOME BIOLOGICAL RAMIFICATIONS. Trans. Am. Fish. Soc. 105 (1): 158-164. Jan. 1976. SFA 21(1).

Pumped storage hydroelectric projects provide an economic way of meeting peak energy needs in electric power systems. Types and locations of pumped storage projects and their basic engineering and operations are described together with the biological impacts common as well as unique to this form of power generation. The rapid increase in the number of pumped storage projects during the last 16 years and projected future construction indicate a serious need for expanded studies to provide for better design features and reduced environmental damage. Biological studies underway and those needed are described and discussed.

76-000483 Liston, C. R.; Tack, P. I. (Dep. Fish. Wildl., Mich. State Univ., East Lansing 48823) A STUDY OF THE EFFECTS OF INSTALLING AND OPERATING A LARGE PUMPED STORAGE PROJECT ON THE SHORES OF LAKE MICHIGAN NEAR LUDINGTON, MICHIGAN. 1974 Rep., Fish. Res., Submitted to Consumers Power Co. Vol. I xx + 166p. 1975. SFA 21(1).

76-000484 Robbins, T. W.; Mathur, D. (Ichthyological Assoc., Inc., P.O. Box 12, Drumore, PA 17518) THE MUDDY RUN PUMPED STORAGE PROJECT: A CASE HISTORY. Trans. Am. Fish. Soc. 105 (1): 165-172. Jan. 1976. SFA 21(1).

The ecology of Conowingo Pond (the lower pond) and the Muddy Run Pumped Storage Pond (the upper pond) on the lower Susquehanna River in southeastern Pennsylvania was studied to determine the effects of operation of the Muddy Run Pumped Storage Station. Nearly all the species of fish present in the lower pond are now found in the upper pond. Extensive sampling in the two ponds indicates no detrimental effects of the station operation on the fishes and fisheries of Conowingo Pond. The creation of the 398.9-hectare upper impoundment serves as an area where biomass of fishes pumped up from Conowingo Pond can be increased and exploited by anglers. Wide fluctuations (up to 15 m in a weekly cycle of operation) in water level limit the reproductions of nest-building fishes in the upper pond. About 6.5 times as many fish larvae were pumped up into the upper pond as left during generation. No reliable quantitative estimates could be obtained on the percentage mortality of fishes passing through the pump-turbines. The mortality of fishes associated with the operation of the pumped storage station appears to be negligible. It is concluded that screens are not needed for the protection of fish at the Muddy Run Station. Even if a satisfactory type of screen could be

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installed substantial mortality due to "gilling" of fishes would occur. Sampling problems unique to the pumped storage project are discussed.

76-000485 Schoumacher, R. (1404 Robertson St., Ft. Collins, CO 80521) BIOLOGICAL CONSIDERATIONS OF PUMPED STORAGE DEVELOPMENT. INTRODUCTORY REMARKS. Trans. Am. Fish. Soc. 105 (1): 155-157. Jan. 1976. SFA 21(1).

76-000486 Simmons, G. M., Jr. (Dep. Biol., VPI & SU, Blacksburg, VA 24061) THE SMITH MOUNTAIN-LEESVILLE PROJECT: A CASE HISTORY. Trans. Am. Fish. Soc. 105 (1): 173-180. Jan. 1976. SFA 21(1).

The Smith Mountain Pump Storage Project consists of two reservoirs in tandem on the Roanoke and Blackwater Rivers approximately 64 km southeast of Roanoke, Virginia. The reservoirs have provided sites for evaluating the impact of pump storage operation on primary productivity, fisheries, and water quality. Due to the location of the dam and the dendritic nature of the basin, the effect of recycling to alleviate detrimental water quality effects caused by thermal stratification were minimal. Moreover, as might be expected, the quality of water found in the upper reservoir depends upon the quality of water being recycled from the lower impoundment. Recycling appears to enhance primary productivity rates, at least in the vicinity of the dam. Pump storage operation does not appear to detract from the fishery in either reservoir. Although comprehensive studies are still needed in many areas, the results of all studies to date indicate a net beneficial effect of pumped storage operation on environmental quality.



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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.



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